

# apc

JUNE 2023 #520

YOUR EXPERT GUIDE TO TODAY'S TECH



WHICH IS BETTER?

WATCH  
EX

WATCH TO SAFER  
STREAMING  
IT'S FREE

HOW TO  
SAVE  
TWITTER

GET STARTED  
WITH MASTODON

DON'T GET  
HACKED ON  
PUBLIC Wi-Fi

ESSENTIAL SECURITY  
SETTINGS



SPEED UP  
YOUR SSD  
FOR FREE!

RUN FASTER,  
LAST LONGER

GROUP TEST

# MINI PCs

## SMALL IS THE NEW BIG

DO YOU REALLY NEED A MASSIVE POWER-HUNGRY PC?  
ULTRA-COMPACTS THAT DO IT ALL

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SONY  
PLAYSTATION VR2

THIS IS THE VR YOU'VE  
BEEN WAITING FOR



# 802.11ax (WiFi 6, AX3000) Multi-WAN Security VPN Routers for SMB

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Aust & NZ

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- Integrated 802.11ax (WiFi 6, AX3000) wireless Access Point; dual band; OFDMA supports up to 2402 Mbps throughput
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**32 x**

VPN



## Vigor2865ax

Multi-WAN VDSL2 35b/ADSL2+ router with 1 x configurable GbE WAN/LAN port, 5 x GbE LAN ports, SPI Firewall, 802.11ax (WiFi 6, AX3000) and 32 x VPN tunnels including 16 x OpenVPN/SSL-VPN tunnels



**50 x**

VPN



## Vigor2927ax

Dual-WAN broadband router with 1 x configurable GbE WAN/LAN port, 5 x GbE LAN ports, SPI Firewall, 802.11ax (WiFi 6, AX3000) and 50 x VPN tunnels including 25 x OpenVPN/SSL-VPN



**2 x**

VPN

## Vigor2765ax

VDSL2 35b/ADSL2+ router with 1 x configurable GbE WAN/LAN port, 3 x GbE LAN ports, SPI Firewall, 802.11ax (WiFi 6, AX3000), and 2 x VPN Tunnels including 2 x OpenVPN/SSL-VPN tunnels



**2 x**

VPN

## Vigor2135ax

Gigabit broadband router with 4 x GbE LAN ports, 802.11ax (WiFi 6, AX3000), and 2 x VPN tunnels including 2 x OpenVPN/SSL-VPN tunnels



i-LAN Technology Pty Ltd trading as DrayTek Aust & NZ

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INTRO

# EDITORIAL

WHAT'S INSIDE APC



EDITORIAL

## I shrunk the computer...

*Is a mini PC right for you?*



**BEN MANSILL**  
Personally prefers enormous PCs, actually....

"Launched as an enterprise form-factor, people quickly realised that for home computer users they offered all the power they needed, in a tiny box that can be tucked away – or even mounted to the VESA plate on the back of your monitor."

Mini PCs are enjoying a strong resurgence, and these most interesting little PCs can deliver capability that defy their small size. Originally launched as an enterprise form-factor, people quickly realised that for home computer users they offered all the power they needed, in a tiny box that can be tucked away – or even mounted to the VESA plate on the back of your monitor.

They really exploded in the early noughties when home media centre PCs boomed (anyone remember Microsoft's Windows Media Center special edition of XP?). Intel went small in a big way with its NUC range (that's Next Unit of Computing, in case you were wondering... and yes, we hate that name, too). Gigabyte also did great things with its Brix range, bringing a bit of style and power to the concept, and suddenly the market was flush with choice.

They can be cheap. Extraordinarily cheap. So in this new era of working from home the appeal of a super-affordable work box was suddenly very appealing. While media centre PCs have largely fallen away as streaming services took over, a great many mini PCs continue to serve up a lifetime's worth of accumulated content – often hooked into a NAS to handle the storage.

The customisability is another big plus. You may have assumed that only a big spacious ATX-sized PC has the tinker-room to upgrade, but most mini PCs are designed to swap out the CPU, RAM and storage, which not only lets you build to order in many cases, but also easily upgrade down the line.

They're generally not gaming machines, though Intel's Skull Canyon NUCs are most certainly very capable and powerful machines.

I hope our article and group test gets you thinking about these small but appealing PCs. There are many pluses, and perhaps a mini PC could be the solution to your own PC needs.

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1

### ASCOMP CLEANING SUITE

If the system boots up more and more slowly and the hard drive gets fuller, then it is high time for a thorough system cleaning! But which data can be deleted without risk, which are still needed for the smooth system and program flow? Cleaning Suite gives the answer! A total of six helpers analyse your system and enable deep cleaning operations. For example, you can delete temporary files, clean browser histories, caches, and cookies from all popular Internet browsers, and prevent installed applications and tools from starting automatically at system startup. The Windows Registry can also be optimised by Cleaning Suite in a targeted manner. The Windows software proceeds very carefully to ensure unrestricted use of your computer even after the cleaning process. On top of that, Cleaning Suite provides advanced features for the Windows Recycle Bin.

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2

### ASHAMPOO PHOTO CARD COMPLETE PACK

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3

### ASHAMPOO REGISTRY CLEANER 2

Ashampoo Registry Cleaner 2 scans the Registry for corrupted, redundant and orphaned entries, effectively decluttering and repairing the database in the process. This prevents issues frequently occurring after long system uptime. By compacting the Registry, Ashampoo Registry Cleaner 2 significantly decreases the system load during read and write operations, making your operating system faster and more stable. The minimalist and functional user interface makes this Registry cleaner also ideal for inexperienced users, as absolutely no knowledge of the inner workings of the Registry is required. While the default settings only detect entries that are safe to remove or repair, the program also comes with a backup system to undo modifications at the click of a button for extra safety.

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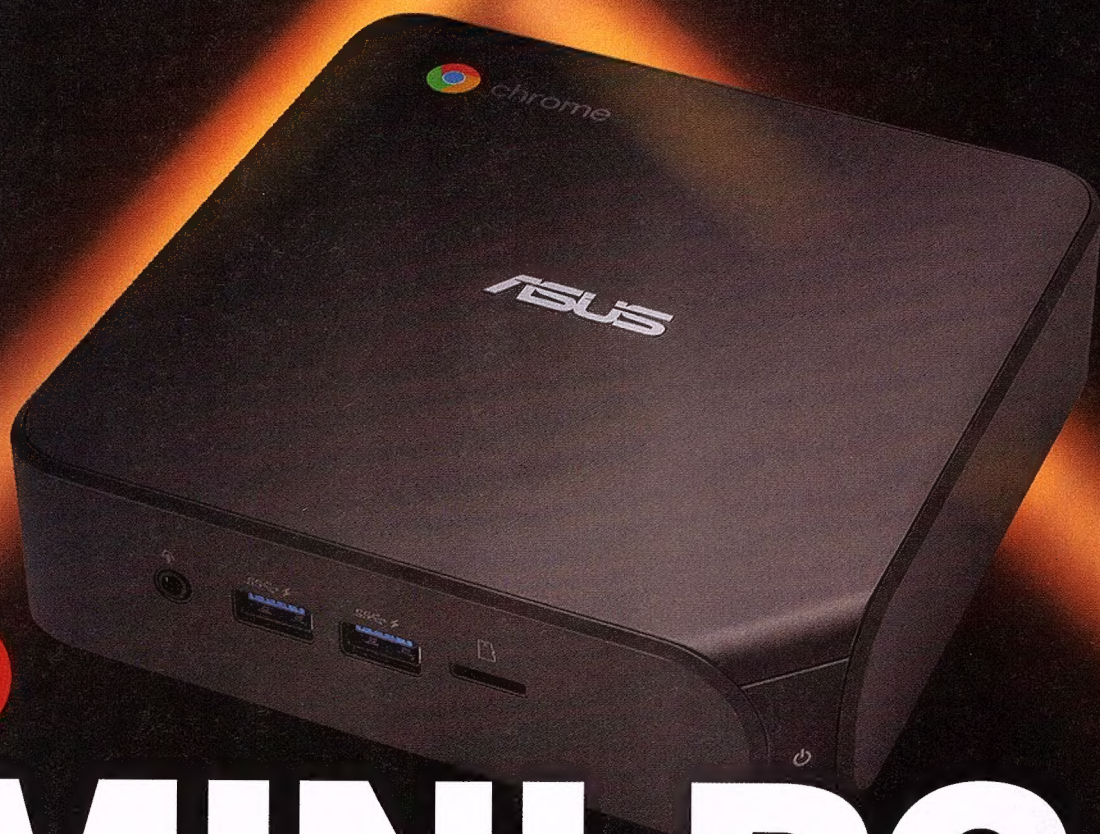


Dolby Vision and Dolby Atmos support for immersive content



Multiple RGB lighting zones with per-key customization are easily synchronized with Aura Sync





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GROUP TEST

# MINI PCs

## SMALL IS THE NEW BIG

DO YOU REALLY NEED A MASSIVE POWER-HUNGRY PC?  
ULTRA-COMPACTS THAT DO IT ALL



Using a VPN is a great way to stay safe on public Wi-Fi, but you should also tweak security settings on your phone, tablet and laptop. Daniel Booth explains which options to turn on and off. **PAGE 064**



## The flat panel pipeline

Jeremy Laird investigates flat panel technology and lifts the lid on what you can expect in the near and not-so-near future. **PAGE 066**





### MSI RTX 4070 GAMING X TRIO

Cool, quiet and actually pretty decent value  
040



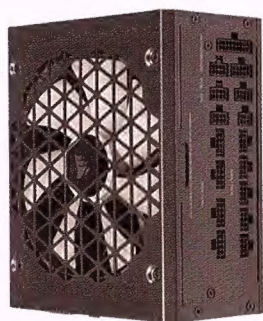
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046



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047



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now to find  
out how



HOW WE DO IT

# Inside APC

Find out all about APC's editorial policies, test practices, how to read the benchmark results, and more.



"Championing technology doesn't mean we're unrelenting yes-men and -women, however, and APC aims to be as objective as possible in all our coverage."

APC is Australia's oldest consumer technology magazine – having been consistently in print for over forty years, since our first issue way back in May 1980 – and we take that heritage and responsibility very seriously. While our focus is obviously on the personal computer the very definition of the PC has changed and shifted markedly since the early 1980s. As such, we touch on many other areas of tech, too, from smartphones and apps to peripherals, accessories, and beyond. We have two goals: to find the best modern tech and to help you make the most of it.

We're also an open church in terms of platforms. We know most people aren't wed to a single brand's products and use a variety of devices. And, like you, APC's journalists want to know what's good in tech – no matter what platform it resides on.

**Independent reviews**

Championing technology doesn't mean we're unrelenting yes-men and -women, however, and APC aims to be as objective as possible in all our coverage. That means identifying the best products from multiple perspectives – the best performance, best value and best features and, ideally, the products that offer the best mix of these three attributes.

As a matter of policy, reviews published in APC are not shared with product-makers prior to print. We will contact vendors under certain conditions; for example, if we have a problem testing a product that seems to indicate it may be faulty, or to invite a vendor to clarify how a particular feature works. If an APC reviewer has any potential conflicts of interest involving a brand, the review will always be assigned to another writer.

**Labs testing**

APC strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible. We use a variety of tools and programs for this, including many freely available benchmark suites for assessing media encoding, general system performance including storage read and write speeds, gaming and battery life.

In most cases, for the benchmark results published in APC, you can assume that higher is better. There are certain tests that deviate from this rule where the opposite is true; in those cases, we've flagged the results with a note explaining as such.

We use both tables and graphs for displaying results; the latter offers better ease-of-readability, but tables are more compact, so we use these in most cases where thoroughness is preferred.

## apc TESTBED

UPDATED FOR 2023

The current APC testbed used in the Labs for benchmarking all components. This testbed is updated as new and relevant technology comes on stream.

|                  |                                          |
|------------------|------------------------------------------|
| CPU              | Intel Core i9 12900K                     |
| Motherboard      | Asus Maximus Z690 Apex                   |
| Graphics Card    | Nvidia GeForce RTX 4090 Founders Edition |
| RAM              | 2x16GB G.Skill Trident Z5 DDR5-6000      |
| Power Supply     | Corsair AX1000                           |
| Storage          | Seagate Firecuda 530 2TB                 |
| Case             | Thermaltake Core P8                      |
| Cooling          | Cooler Master Flux PL360 AIO             |
| Operating system | Windows 11 Pro 22H2                      |

## apc AWARDS



### APC EDITOR'S CHOICE

When a product scores 4.5 out of 5, it carries the Editor's Choice Award. These are products that exceed expectations and deliver a quality experience up there with the very best.



### APC HIGHLY RECOMMENDED

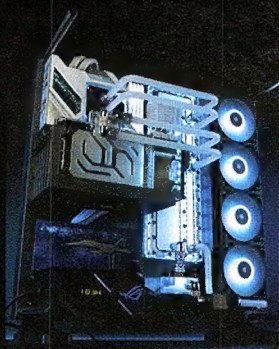
You will see this award if a reviewed product has scored four out of five stars. It means most people can expect satisfying performance from the product, and that we would use it ourselves.



ULTRACORE  
CYBORG NINJA



EXPLORER  
SPACE FLIGHT



HYPERGATE  
LIGHTNING ELITE



AFTERSHOCK 



AFTERSHOCK HAS TO TAKE IT FOR ITS  
**INSANE** PERSONALISED BUILDS.

AUSTRALIAN  
**PC**  
AWARDS  
WINNER 2020 / 2021

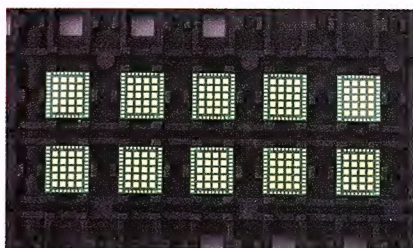
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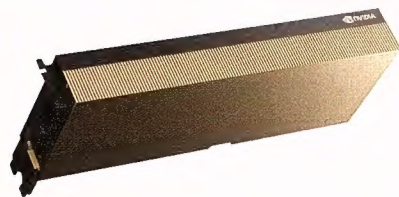


© Intel

## INTEL DISCONTINUES BITCOIN-MINING CHIPS

It's been just a year since Intel officially announced its Bitcoin-mining Blockscale ASICs, but in June the company announced the end of life of its first-gen Blockscale 1000-series chips without announcing any follow-up generations of the chips. The company told our colleagues at *Tom's Hardware* that "As we prioritise our investments in IDM 2.0, we have end-of-lifed the Intel Blockscale 1000 Series ASIC while we continue to support our Blockscale customers."

Intel hasn't announced any next-gen Bitcoin mining products and its Blockscale ASIC landing pages are now all inactive. Intel's initial entry into the market for bitcoin-mining chips came at an inopportune time, as its chips finally became available right as Bitcoin valuations crashed at the end of the last crypto craze.



© Nvidia

## TWITTER IS REPORTEDLY BUILDING A CHATGPT RIVAL.

Despite advocating for an industry-wide halt to AI training, Elon Musk has reportedly kicked off a major artificial intelligence project within Twitter. The company has already purchased approximately 10,000 GPUs and recruited AI talent from DeepMind for the project that involves a large language model (LLM), reports *Business Insider*.

One source familiar with the matter stated that Musk's AI project is still in its initial phase. However, acquiring a significant amount of additional computational power suggests his dedication towards advancing the project, as per another individual. Meanwhile, the exact purpose of the generative AI is unclear, but potential applications include improving search functionality or generating targeted advertising content.



HARDWARE

## Intel's Meteor Lake launch this year

*Its first PC chips with TSMC technology.*

During its Q1 2023 earnings report, Intel announced that it is ramping production wafers for its Meteor Lake processors for a launch in the second half of this year. These chips will be partially fabbed on the 'Intel 4' process node, a key milestone for the company as it works towards delivering five nodes in four years – a goal that the CEO Pat Gelsiner reiterated is still on track. Intel says that two of those five nodes are almost complete.

Notably, the Meteor Lake processors are Intel's first desktop PC chips that will also use components fabbed on TSMC's process nodes. Intel announced this drastic step two years ago as it grappled with the reality that its process node tech had fallen behind TSMC. For what it's worth, the company announced back in 2021 that these chips would arrive in 2023, and they are obviously still on schedule for that launch. Intel will use this blended chip approach for several new chip generations.

Intel also says that its Arrow Lake and Lunar Lake products remain on

schedule to launch in 2024. Intel will use its 3D Foveros packaging tech as the bedrock for the consumer market's Meteor Lake, Arrow Lake, and Lunar Lake processors. This technology allows Intel to stack chiplets vertically atop one unifying base die with a Foveros interconnect.

Not only will Meteor Lake represent the first chips with the Intel 4 process node, an EUV-enabled node that is a critical step for Intel as it looks to right the ship, but they will also be the first Intel desktop PC chips that use process node tech from TSMC.

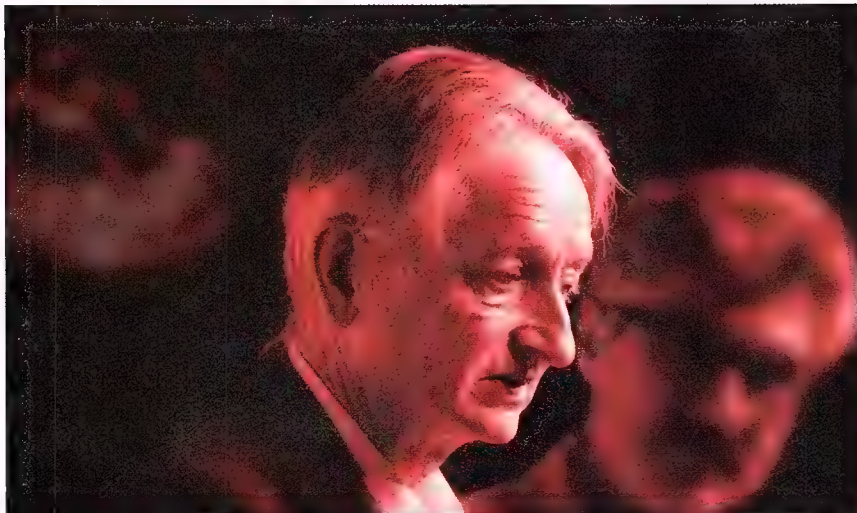
Meteor Lake's new design will use multiple different process nodes in the same chip package. In this case, three tiles (similar to chiplets) use TSMC process nodes – the GPU, SOC, and IOE tiles.

This technique affords cost advantages, as the larger, older TSMC nodes can be used for functions that aren't as sensitive to performance. Offloading those functions from the CPU tile also improves yield, and thus cost, for this critical component.



© Intel





## The ‘Godfather of AI’ quits Google

*Fears where things are headed.*

Geoffrey Hinton, one of the pioneers of AI, has left Google after a decade of working with the company. In an interview with *The New York Times*, Dr. Hinton explains that he left the company in order to speak openly about the dangers of AI.

Known as a “Godfather of AI,” Dr. Hinton’s work has enabled machines to “see” objects. In 2018, he was awarded the Turing Award along with two others for their work in deep learning, which laid the groundwork for the AI capabilities we are witnessing today. However, despite the

accomplishments and groundbreaking developments based on his research, Dr. Hinton says that part of him regrets his life’s work.

“I console myself with the normal excuse: If I hadn’t done it, somebody else would have,” Hinton said during the interview, addressing the potential of AI to be used to spread misinformation. “It is hard to see how you can prevent the bad actors from using it for bad things.” He notes how the growing use of AI to create fake content, consumers would “not be able to know what is true anymore.”

““I console myself with the normal excuse: If I hadn’t done it, somebody else would have,” Hinton said during the interview, addressing the potential of AI to be used to spread misinformation.”

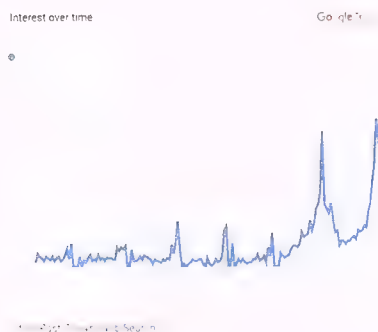
## VPN PORN SEARCHES SOAR IN UTAH

*Amid mandatory age verification bill.*

Porn fans living in Utah, United States, seem to be rapidly turning to VPN services as a means to circumvent current Pornhub restrictions. The blocks come into force on May 1, as an act of protest ahead of a state bill that will require all porn websites to enforce an age verification system. Google searches for virtual private networks (VPNs) have been skyrocketing since, with a peak registered on May 3, the day the new law came into force.

“Utah’s age-verification law shows a worrying trend to further restrict digital freedoms and disregard data privacy across the US,” said a spokesperson of secure VPN provider Private Internet Access (PIA). A surge of interest in VPNs

across Utah occurred as people simply connect to a server located in a US state or foreign country where the restriction isn’t yet enforced.

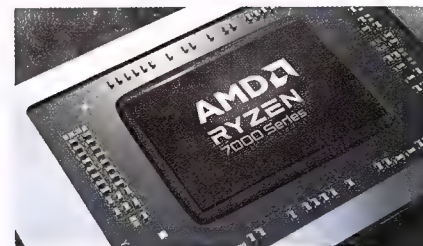


## MICROSOFT REJECTS \$63K+ TWITTER API SUBSCRIPTION

Twitter has lost a valuable partner as Microsoft announced it is dropping the maligned social network from its Digital Marketing Center’s (DMC) social media management tool starting on April 25th.

The change coincided with the decision by Twitter to start charging an eye-watering US\$42,000-a-month starting enterprise subscription to Twitter’s new API. Unfortunately, such a decision also affects many third-party Twitter app developers who can no longer afford to maintain their apps, many of which add more customisations and features than the official Twitter app.

Twitter’s new owner, Elon Musk, chimed in on the news accusing Microsoft of “training illegally,” presumably its Bing Chat and Bing Search features, and threatening a lawsuit against the company.



## AMD ANNOUNCES RYZEN 7040U MOBILE PROCESSORS

AMD has announced its 7040U “Phoenix” series processors, including some of its first with its XDNA-powered AI engine. There’s still no word on the 7040HS processor specs, though the company did tell us that the HS chips are now shipping to OEMs and will arrive at retail in the coming weeks.

The lineup is headlined by the AMD Ryzen 7 7840U, paired with Radeon 780M graphics and Ryzen AI using the XDNA architecture. AMD suggests it’s stronger than both competing Intel PCs and Macs.

AMD compared the 7840U to Intel’s Core i7-1360P, claiming it offers up to 29 percent better content creation performance, 37 percent improvement in web applications, 39 percent in productivity, 89 percent on Passmark, and 128 percent improvement in media encoding. ■



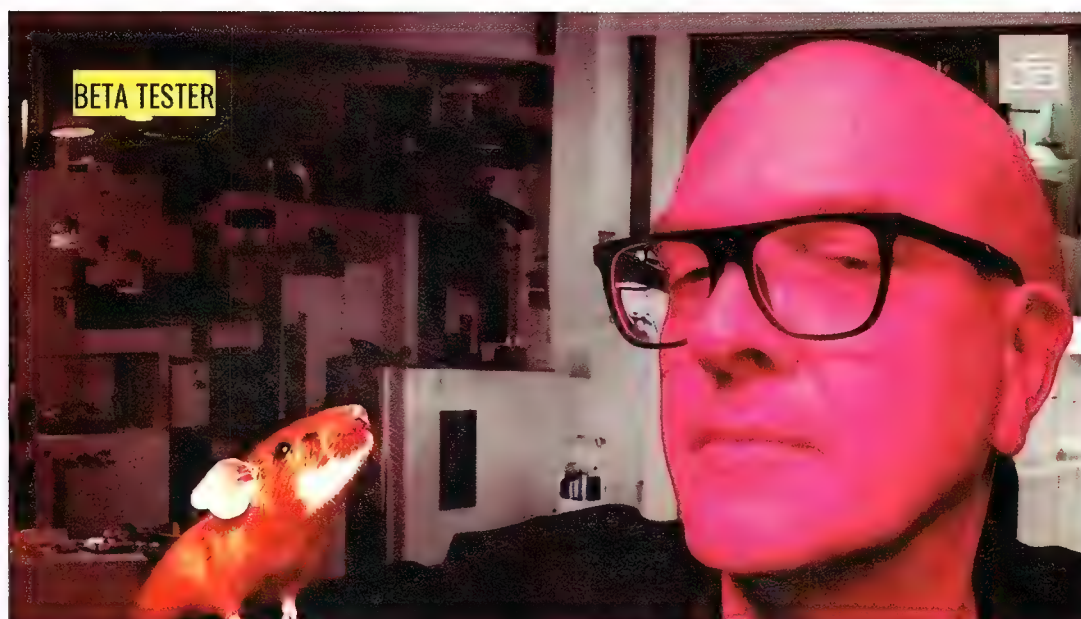
TECH BRIEF

# The great AI art scandal

Artist wins prestigious photography prize with AI, refuses the award, gets scrubbed from the competition, and says we need to talk about human AI art scandal.

While created in the style of artist Boris Eldagsen, this image was made entirely by AI.





 Sony  
World  
Photography  
Awards

Left: German artist Boris Eldagsen fooled the judges to make a point about the capabilities of AI in art.

Last year saw the emergence of public-facing AI tools, and an ongoing slew of stories about how people are using the tech, as well as the debate over what it should be used for. Now an artist, who calls himself a “cheeky monkey”, has shocked the photography world by winning one of its major prizes, before revealing the ‘photograph’ was an AI creation, refusing the award, and calling for AI to be banned from such competitions.

German artist Boris Eldagsen entered and won the creative open category at the annual Sony World Photography Awards with an image called *Pseudo Amnesia: The Electrician*. As part of the judging process he also gave the judges certain assurances about the work, claiming it was a “co-creation” of AI. The creative category is specifically about original and experimental approaches to photography, so one can see that using cutting edge tech to assist in altering a photograph would seem to fit such criteria.

### Cheeky monkey with a cause

But, Eldagsen now admits “I applied as a cheeky monkey, to find out if the competitions are prepared for AI images to enter. They are not.” Eldagsen calls this a “historic moment” for photography and directly addresses his peers and the wider community:

“[This] is the first AI generated image to win in a prestigious international photography competition,” said Eldagsen. “How many of you knew or suspected that it was AI generated? Something about this doesn’t feel right, does it?”

“AI images and photography should not compete with each other in an award like this. They are different entities. AI is not photography.

Therefore I will not accept the award.”

Eldagsen goes on to call for an “open discussion” on “what we want to consider photography and what not.” He says his intention with this stunt was to “speed up this debate” about whether AI should be a part of photography awards and points out he’s been a photographer for 30 years before using AI.

### Misled judges

For its part, a spokesperson for the Sony Photography Awards told the BBC it felt Eldagsen had misled the judges, on the basis of which “we felt that his entry fulfilled the criteria for this category, and we were supportive of his participation.”

“Additionally, we were looking forward to engaging in a more in-depth discussion on this topic and welcomed Boris’ wish for dialogue by preparing questions for a dedicated Q&A with him for our website.” As he has now decided to decline his award we have suspended our activities with him and in keeping with his wishes have removed him from the competition.”

In some ways this will be a re-run of a well-honed argument across various disciplines, which over history have treated technological advance warily: In terms of AI especially, a story that stuck in my mind recently was when an AI artist won an art prize and was brazenly unapologetic about it, saying the art world was “in denial.”

### What is real, anymore?

Photography itself was viewed with suspicion and in some cases fear long after its invention. But it is not hard to see how a technology that conjures unreal but real-looking images from thin prompts is seen as a useful tool by

some photographers and an existential problem by others. Part of the medium’s appeal, after all, is surely that a photograph is an authentic image of the world as it was in some spot of time.

“There is a problem here in the photography industry,” said photographer and blogger Feroz Khan. “With this intention, Boris has stated that he wants photography contest organisers to have separate categories for AI images.

“I appreciate him for wanting this distinction in photo contests. Yes, he entered an AI image into the competition, but it doesn’t seem he was out to defraud anyone. He wanted to highlight an issue that certainly needs a lot more attention from everyone.”

### Policing AI entries

Khan ended by saying that Eldagsen’s stunt had “clearly shown that even experienced photographers and art experts can be fooled.” Which will not be news to anyone interested in the fascinating history of art forgery, but does get at one of the big problems here. Eldagsen by his own admission did mislead the judges to make his point before coming clean: But others will be all-too-happy to fake it to make it, and take the plaudits without ever divulging a given work’s origin. Do competitions like these need anti-AI tools in order to enforce rules?

An exhibition of the winners and shortlisted images from this year’s Sony World Photography Awards were displayed in London. Eldagsen’s image was removed from the exhibition and website, but can be seen alongside some of his other work at Photo Edition Berlin.

**Rich Stanton ■**



END USER

## Why do so many new blockbuster games suck?

Major publishers are having a hard time cutting through in 2023, but why? ponders Shaun Prescott.



Shaun is an Australian editor for *PC Gamer*, *GamesRadar* and *PLAY*, and writes for *APC*, *TechRadar* and more.

Is it still possible to make a stable, enjoyable, original, and critically acclaimed blockbuster videogame? To resort to a cliché, if you were to awaken from a 20 year deep sleep into the first half of 2023, the evidence would suggest that the task is near insurmountable. The big name publishers pushing out the biggest name products with the biggest budgets are the loudest marketing, are just not having a great time at the moment.

Square Enix's *Forspoken*? Plagued with graphical issues, with a Metascore of 64 on PS5. *Destiny 2: Lightfall*? A 66 Metascore. *Minecraft Legends*? Arkane's *Redfall*? Both also critical flops, the latter plagued with egregious technical issues. Exceptions include *Dead Space*, which is a remake, and *Resident Evil 4*, which is also a remake. Games that have managed to release in a decent state to critical approval (if not outright "acclaim") are *Hogwarts Legacy*, *Wo Long: Fallen Dynasty* and *Dead Island 2*. *Star Wars Jedi: Survivor* met with critical acclaim, but was also heavily criticised for its woeful performance across all platforms.

What's going on? It's true that the games press is more critical than it was say, a decade ago, especially when it comes to poor

technical performance, where standards have increased dramatically. All would agree that higher critical standards is a good thing, except perhaps, developers and publishers.

There's also the everpresent elephant in the room, COVID-19, which dramatically affected development on virtually every game in development during lockdown periods. With roughly two years of uncertainty and blemished production schedules, it's probably to be expected that games are releasing a little short of their creators' visions. My colleagues at *PC Gamer* have written extensively about the terrible state of PC ports during the last 18 months, but performance issues plague consoles too, even the unofficial target platform, the PS5.

A more abstract question presents itself: Are games just too... big? Two of the biggest critical successes of 2023 so far are remakes of games that are over a decade old: *Dead Space* and *Resident Evil 4*. These are 10-14 hour narrative experiences, largely linear, focused on tension, world building, and with a small handful of great ideas well executed.

Compare that to *Redfall*, probably the biggest disaster of

2023 so far. Arkane, best known for its detail-oriented immersive sims, tried to serve up an open world looter shooter in the vein of *Destiny 2*, but failed miserably. The scope of it, you could argue, was just too big. Speculation abounds that either Microsoft or Bethesda commanded the studio to make a zeitgeisty game outside of its comfort zone, and while that theory cannot be substantiated thus far, it certainly feels that way.

Games are just so big, so expensive to make, and consumer expectations are so high, that it really seems like a crapshoot at the moment. The pressure for studios to forever be pushing the envelope on graphical fidelity and scope is a remnant of times now past when it was both possible and exciting, as computer technology evolved alongside. Look, for example, at the leaps made throughout the 1990s alone! No such leaps are really possible anymore, at least, not on a mere screen. Maybe it's time for studios to make smaller, more formally innovative games, or else, to find a way to normalise all games taking upwards of six to ten years in development. That's Bethesda Game Studios *modus operandi* nowadays; let's see how *Starfield* goes when it releases later this year.

■ Shaun Prescott



# AI can now read your mind

Researchers gave brain scans to a large language model and now it knows how to read what people are thinking. Joel Burgess ponders the sci-fi implications of AI brain scanners.

Anyone who has worried about some of the nuances of George Orwell's prophetic *Nineteen Eighty-Four* novel ever coming true you can now rest easy knowing it's only a matter of time until we have a fully functioning thought police regime.

Researchers from the University of Texas, Austin, published a study in *Nature Neuroscience* detailing a piece of AI-powered software that can decode brain patterns into language, using non-invasive functional Magnetic Resonance Imaging (fMRI). This research is the first instance of neural activity being transformed into continuous understandable language without the need for surgically implanted probes.

Jerry Tang, the lead researcher on the paper, said in a press briefing that; "Eventually, we hope that this technology can help people who have lost the ability to speak due to injuries like strokes, or diseases like ALS."

The researchers trained the underlying GPT-1 large language model using books, Reddit comments and autobiographical stories from radio podcasts. This model was then encoded using data from three participants who

listened to 16 hours of stories whilst in an fMRI machine. Each decoding model had to be customised for a specific participant, who was then shown a novel story to test the accuracy of the AI predictive model.

The fMRI machine measured small changes in blood flow in three parts of the brain known as the speech, association and prefrontal cortical regions. Results for each of these regions in both the left and right hemispheres were tested individually and then also pooled for a combined whole-brain result. The machine was tasked with predicting continuous language when subjects were read, shown or imagining sentences or stories that were not part of the training set.

The three trained models were able to achieve between 10 and 25 percent accuracy in predicting similar or identical narratives depending on the volume of subject encoding data provided. This means that you could expect the model to get 'the gist' of about a quarter of the information correctly, with the portion of exact sentence matches being significantly smaller. Errors were not uncommon, but all outcomes

were statistically shown to be significantly better than any chance based interpretations by the AI model.

At present the technology requires the cooperation of subjects in order to function, but the researchers behind it write in the paper that; "brain-computer interfaces should respect mental privacy".

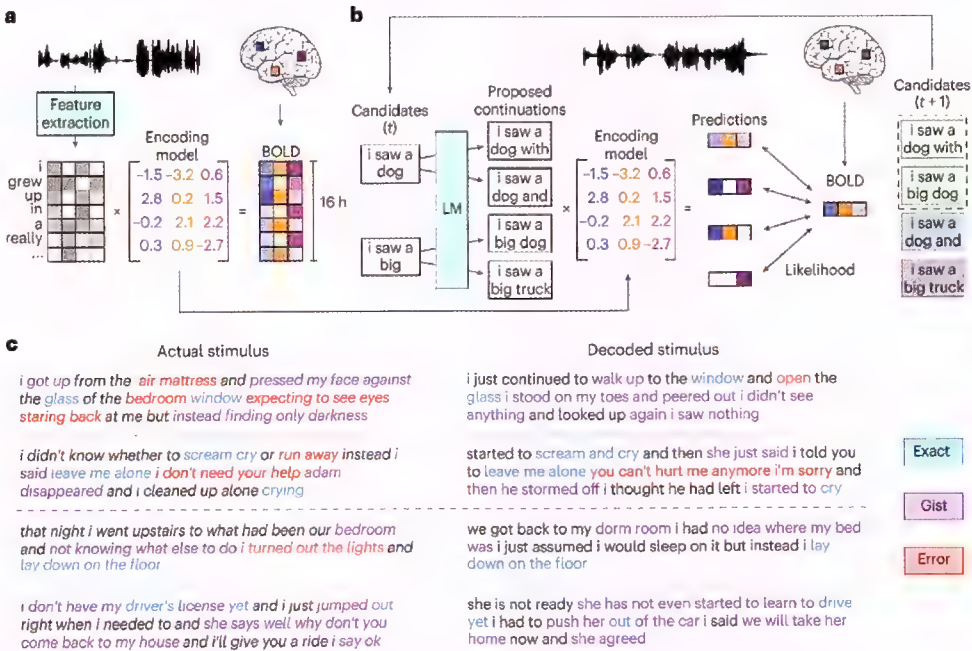
The fledgling capabilities of the current software throws up plenty of hurdles for anyone hoping to read the thoughts of unwilling participants. MRI machines are also still a long way off being compact (or large) enough to be used for anything too nefarious. That said, there's no physical reason why this technology couldn't be used in the very near future on someone being interrogated ... at least once the software is robust enough for models to be translatable from person to person.

While the AI is certainly not going to be winning any comprehension awards just yet, it definitely shows that the possibility of thought police is starting to seem like a real possibility rather than sci-fi fantasy.

Joel Burgess



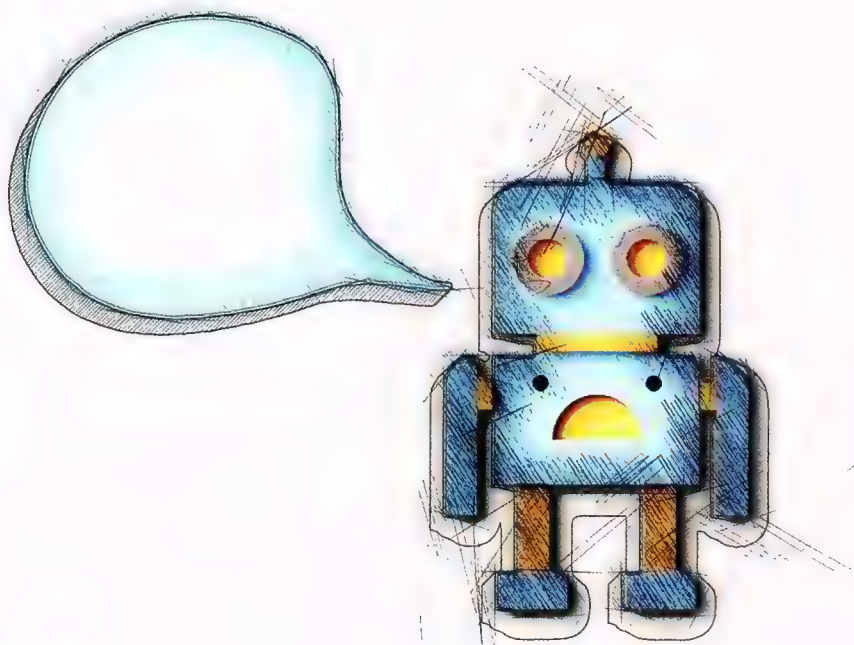
Joel is one of the senior journalists on *APC* magazine and apart from being the resident laptop, monitor and fitness tech geek, he's also pretty into surfing his local Sydney beach breaks when he's not in front of a screen.





# Mucking about with AI

Running a "ChatGPT-lite" on your own PC.



**Jarrod Walton**  
Jarrod has been described as an AI by people he meets at parties.

Last month, I quipped that we're not yet at the point where you can run your own ChatGPT instance. While technically true, the amount of progress we've seen with different models and algorithms proves how short-sighted that statement was.

Much like Stable Diffusion last year, research in large language models (LLMs) means that you can now run your very own chatbot on your local PC. ([tinyurl.com/local-chatbot](https://tinyurl.com/local-chatbot)) Caveats apply.

This isn't ChatGPT. You'll also want a GPU with as much VRAM as possible, and plenty of system memory – 32GB is a realistic minimum. Nvidia GPUs are vastly preferable as well, which seems to be what 99 percent of AI researchers are using. Finally, given how much has changed in just a few weeks, don't be surprised if the gap between a locally running instance and

ChatGPT narrows.

Over the past month, we've gone from needing an RTX 4090 for OPT-6.7b – Open Pretrained Transformer language model trained with 6.7 billion parameters – to being able to run a model with twice as many parameters on a 10GB GPU.

**"If ChatGPT, Microsoft Bing, and Google Bart say some inappropriate things, what can be done with an unregulated locally running model is a different matter."**

Incidentally, the GPT-3 model used for ChatGPT was trained with 175 billion parameters. The reduction in requirements is thanks to loading the model first in 8-bit mode, and now in 4-bit mode, with the latter cutting memory requirements by 75 percent. While 4-bit versus 8-bit versus 16-bit might sound bad, for deep learning inferencing where the calculations often trend toward 0 or a large number, it apparently doesn't matter that much.

Getting the models running in less memory isn't the only change. GPT-3 wasn't necessarily

trained in an ideal fashion, in part because what that might mean isn't entirely clear. Things keep getting adjusted, and a different model called LLaMa claims to deliver similar performance with just 7 billion parameters to what GPT-3 does with 175 billion. LLaMa-7b could already run on 24GB GPUs, but 8-bit mode enables up to the 13b model, and with 4-bit you can run the LLaMa-30b on a 24GB GPU.

8-bit and 4-bit effectively double and then quadruple performance, and that's in a relatively untuned state – a Core i9-12900K appeared to be the bigger limit on maximum throughput in testing, topping out at around 25 tokens per second. That's 1,500 words per minute, achievable on a 4090, 3090, or even a Titan RTX. Meanwhile, GPT-4 training is underway, apparently with one trillion parameters, though it supposedly will have similar hardware requirements to GPT-3.

Be warned that the output from these locally running chatbots feels incredibly dumb at times – much of the secret sauce that went into ChatGPT probably isn't present. If ChatGPT, Microsoft Bing, and Google Bart say some inappropriate things, what can be done with an unregulated locally running model is a different matter. One model was apparently trained on 4chan content, for example, and is available via BitTorrent. (Definitely NSFW!)

Also, new hardware is coming. Nvidia just announced its H100 NVL, a new dual-GPU variant of Hopper in PCIe format, with 94GB of HBM3 per GPU, compared to the 80GB on previous H100 models. With two cards communicating via triple NVLink connectors with 600 GB/s of bandwidth, you have a 188GB solution that could theoretically run in a server – more than enough for LLaMa-135b.

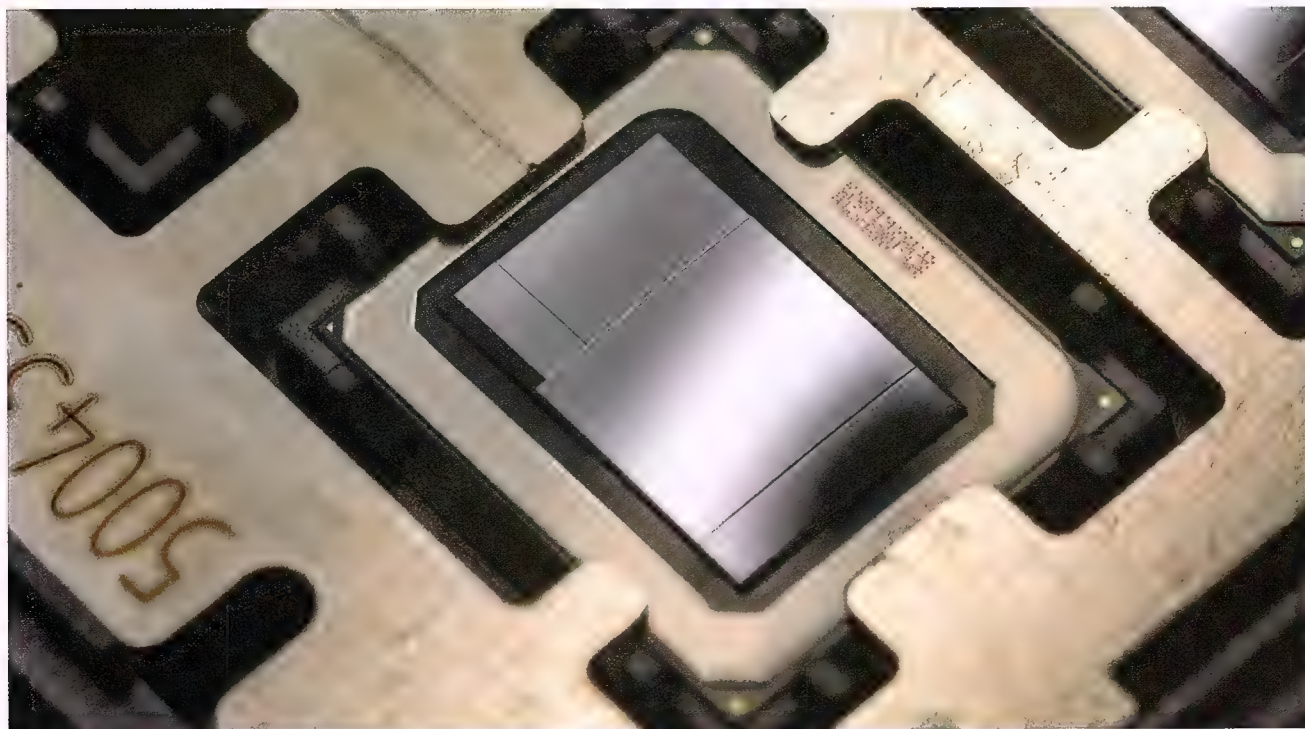
**Jarrod Walton ■**



TRADE CHAT

## Rumours or reality?

*It's simple, Intel's Meteor Lake is a mobile chip.*



A disclosure. I don't just enjoy the tech rumour mill, I'm involved in it. It's fun to track upcoming chips from Nvidia and Intel as they progress from mere whisper to retail reality. But as a journalist, you're only as good as your next rumour, which is why things can get a bit silly sometimes.

That's exactly what's happened with the rumours revolving around Intel's upcoming desktop Meteor Lake CPUs. But actually, it's simple. Meteor was probably never meant to be a desktop processor. That Intel's Meteor Lake processors exist is far from a secret. It is mentioned by senior Intel suits every time the company updates the markets on its progress. Meteor Lake, we are assured, remains on track for production later this year.

Meteor Lake will be its first consumer processor to use chiplets or, in Intel parlance, tiles. It will be four tiles: one for the CPU cores, one for the integrated GPU, an SoC tile, and an IO tile. It will also be the first CPU on Intel 4, the upcoming process node formerly known as 7nm. This is all public information, as is the fact that

Meteor Lake's graphics tile will be manufactured by TSMC.

Where the silly season rumours come in involves the specifics around Meteor Lake's core counts and the exact SKUs it will be available in. The first big controversy around it was a rumour claiming that it will be limited to just six performance cores. That's fewer, notably, than both Alder Lake and Intel's incumbent CPU architecture Raptor Lake.

Only six big cores? What was the company thinking? This obviously meant that Intel 4 was a disaster and Intel's plans in tatters. After all, it turns out that it's not even good enough to produce a CPU with eight performance cores. Then came a rumour that Meteor Lake was in such bad shape that the desktop variant, Meteor Lake-S had been cancelled altogether. What a catastrophe.

Except, that's likely all wrong. Or rather, it's a misinterpretation. It's more likely that Meteor Lake has always been targeted at mobile platforms. Indeed, Intel has form when it comes to rolling

out chips on a new production node for mobile first. It's remarkable how quickly everyone seems to have forgotten Ice Lake, Intel's first 10nm CPU, which was mobile only. Indeed, Tiger Lake, Intel's second 10nm architecture, was mobile-only too. And both Ice Lake and Tiger Lake had fewer cores than Intel's desktop CPUs at the time.

Wind back to Intel's 14nm node and the first 14nm CPU was the Broadwell mobile chip. Okay, Intel later released a few Broadwell desktop SKUs, but it was primarily a mobile processor. As is often the case, rumours around Meteor Lake are connected to reality. It probably will be limited to six performance cores, and there probably won't be a desktop variant. But that's likely because that's what Intel intended. So, Meteor Lake will be the first Intel 4 processor and for laptops only. It will be followed by Arrow Lake, which is closely related, but actually designed for the desktop. All the guff about cancellations and downgrades is just the internet getting wound up about nothing. **Jeremy Laird** ■



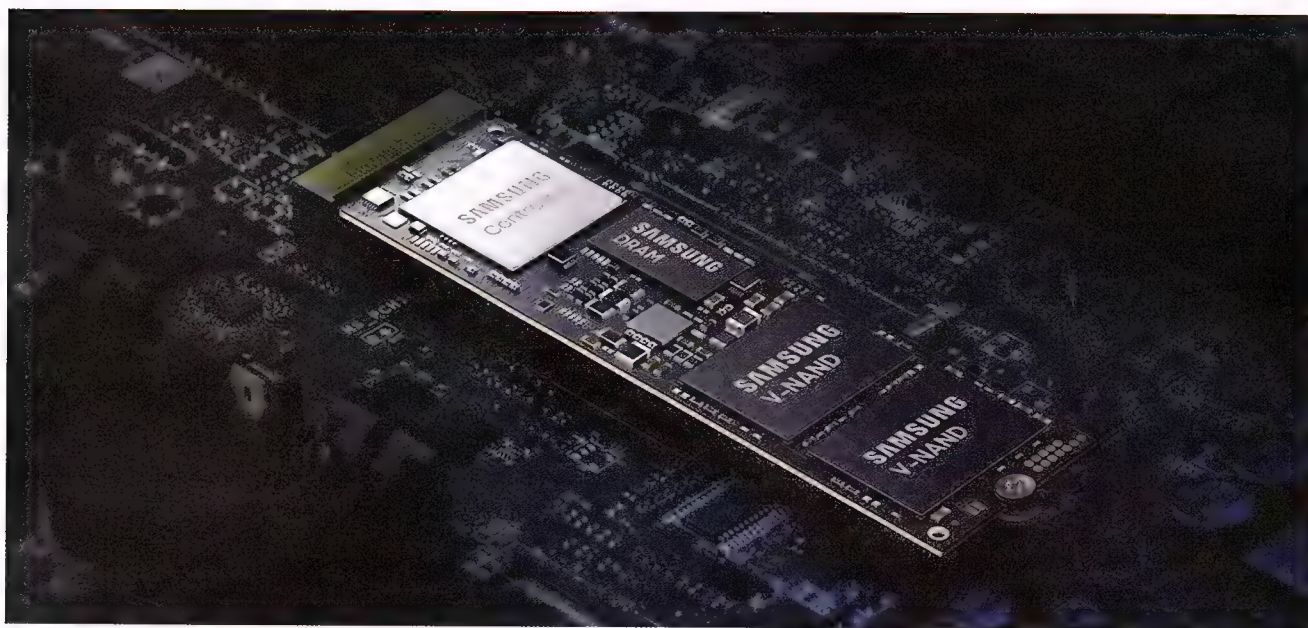
**Jeremy Laird**  
Has a black leather jacket just like Jensen's.



TWO BITS

# Why are we stuck with M.2 when U.2 is so much better?

*U.2 has the edge.*



Chris has been elbow deep in PCs since before the turn of the millennium, and he wouldn't have it any other way.

As APC's resident PC component writer, I handle a lot of different PC parts. But there's one in particular that manages to irk me every time I use one. I'm referring to M.2 SSDs. In fact, I hate them. They have so many unnecessary drawbacks. They're well suited to laptops, but for a DIY PC? Nope. What's really frustrating is that there's a ready-made alternative with all of M.2's advantages, and essentially none of its drawbacks. It's called U.2. Sadly, despite fleeting inclusions on some high-end motherboards a couple of generations ago, U.2 never caught on in the consumer space. And I want it back.

When the first SSDs launched, it became apparent that the aging SATA and mSATA interfaces were insufficient to handle the increasing speeds of these swishy

new flash-based drives. A new standard was required. NVMe Express was developed specifically for non-volatile memory (NVM), but NVMe isn't a connector, it's a specification or protocol. NVMe device connections include PCI Express add-in cards and the SATA Express, M.2 and U.2 connectors.

SATA Express never caught on. Some high-end Intel Z97 and X99 motherboards came with SATA Express ports, but I never tested a SATA Express drive and all support disappeared after a short time.

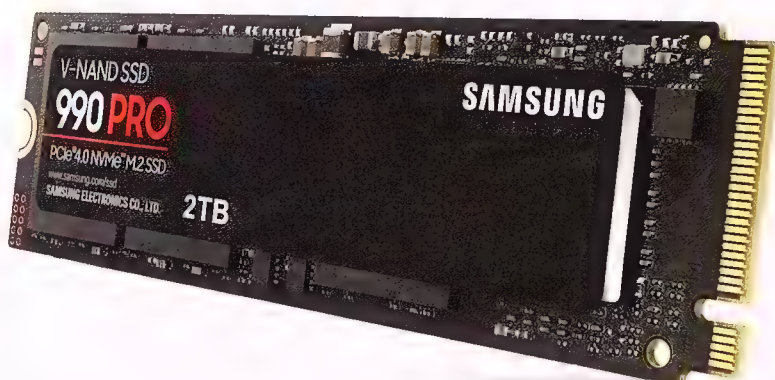
U.2 – my champion – briefly made appearances on some high-end consumer motherboards a few years ago, but it's always been more of an enterprise-oriented solution. It lives on and some workstation motherboards still include U.2 ports.

## M.2's elevation

That brings me to M.2. For some bono-headed reason, somebody decided that attaching an SSD directly to the motherboard was the best path forward. M.2 rapidly became the most widely adopted connection and to this day, almost every performance-based consumer SSD is an NVMe M.2 drive.

So, why do I think M.2 SSDs are so bad? Where do I begin? A typical 2280 size drive is too small, both physically and capacity wise. They run hot and are prone to throttling. They often sit right next to (if not directly underneath) a heat-dumping graphics card. Coincidentally, in this issue I reviewed a Teamgroup Siren Duo360 AIO cooler which also comes with an integrated SSD water block. Sadly, it highlights a

"U.2 – my champion – briefly made appearances on some high-end consumer motherboards a few years ago, but it's always been more of an enterprise-oriented solution. It lives on and some workstation motherboards still include U.2 ports."





growing problem with SSDs. The fact that PCIe 5.0 SSDs require chunky motherboard mounted heatsinks – let alone water cooling – is a pretty sad state of affairs.

PCIe 4.0 and particularly PCIe 5.0 M.2 slots add complexity to motherboards making them more expensive. They take up a lot of PCB space. They're difficult and fiddly to install, sometimes requiring the removal of the GPU and the removal of a half dozen tiny screws – which I too often drop and lose to the seventh circle of hell. Then you've got to put it all back together, and hope that a weak, flimsy or crumbling thermal pad aligns, and the drive is actually securely aligned in the M.2 slot. There's a handful of reasons to start with.

### Why U.2 rocks

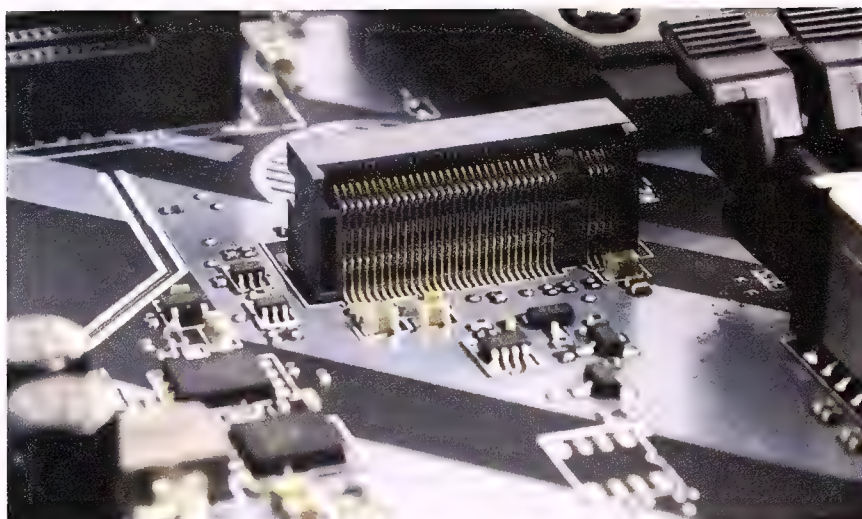
U.2 drives eliminate all of these problems, while keeping all of the benefits. A U.2 drive can more or less be considered a modernized 2.5in SATA drive with support for an NVMe PCIe connection. In my opinion, they are superior to M.2 drives in basically every way. Here's why.

A U.2 drive can be isolated from other hot components, particularly the graphics card. A physically separate drive is easier to cool. Most PC cases retain 2.5in or 3.5in drive bays, and plonking three or four U.2 drives into a space cooled by a 120mm intake fan will keep them cool at all times. That'll prevent them from throttling, leading to a longer life and hence keep your data safer. The latter point can often be overlooked.

A 2.5in form factor drive can easily incorporate a sizable heatsink, either internally or form part of the drive's housing. On top of that, SSD manufacturers won't be restricted to the M.2 2280 form factor PCB. That means there's more PCB space available for more dies and larger capacities, or physically larger controllers with improved heat dissipation properties. They could even use cheaper manufacturing nodes.

And of course, getting rid of a bunch of motherboard-based M.2 slots frees up motherboard PCB space and gets rid of the need for giant slabs of metal to keep the drives cool. It's easier to route signals from stacked connectors rather than have electrically sensitive traces running every which way across the motherboard. I'm certain that a motherboard with one M.2 slot and four stacked U.2 ports would be cheaper to manufacture. Is it any wonder that a high-end motherboard can cost well over \$1,000?

A lesser known but important fact is that U.2 drives use 12V power, whereas M.2 uses 3.3V. There's some industry momentum towards shifting PCs to 12V only designs. Intel released the ATX12VO standard in 2019 but it hasn't caught on.



© Shutterstock

"M.2 drives are a more elegant solution. No cables mean a cleaner build. But do I care about seeing an inch of cable sticking out the side of my motherboard before it disappears through a hole behind the back of the motherboard? Not. One. Bit."

A 12V only PC will be more efficient, simpler in design and hopefully cheaper to manufacture. There's another point in U.2's favour.

A 2.5in U.2 SSD is easy to install. U.2 is hot swappable. It can be installed in one of the million cases with tool less 2.5 in drive bays. Plug the cable and power connector in and you're good to go. Perhaps some tiny systems would be disadvantaged, but it's not like a 2.5in drive bay or three requires a monster sized case. Only the smallest NUC type systems would be disadvantaged, and they're more likely to use custom motherboards and could still include M.2 slots.

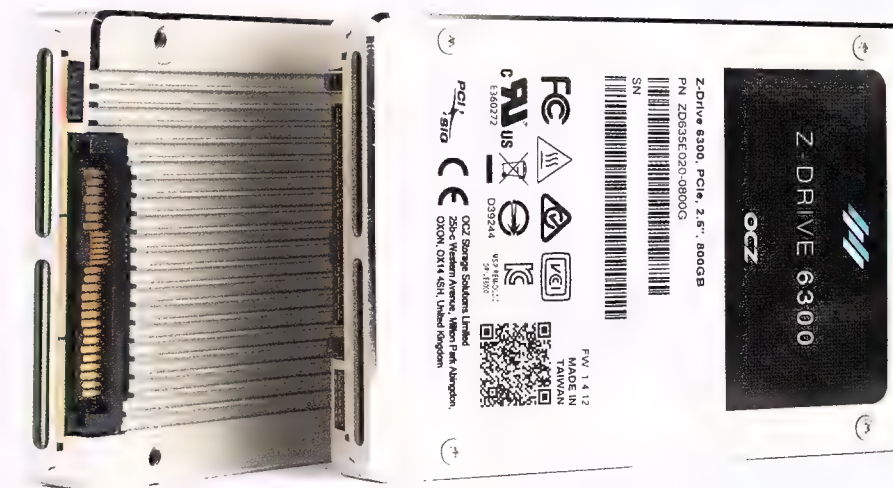
### What I desire

Are there drawbacks to using a U.2 over an M.2? Well, you need to use a cable to connect it. Some would say that M.2 drives are a more elegant solution. No cables mean a cleaner

build. But do I care about seeing an inch of cable sticking out the side of my motherboard before it disappears through a hole behind the back of the motherboard? Not. One. Bit. Someone could make an RGB U.2 cable. Oh, I can't believe I went there.

Sorry, but I can't fall in love with M.2. They're small, fiddly, hot, more difficult to install, add cost and complexity to motherboards and they're capacity limited. U.2 addresses all of these weaknesses at the cost of requiring a little more case space and the use of cables. Big deal. Those are trade-offs I'm more than willing to accept.

U.2 drives clearly have the edge. Give me the option and I will follow. Whatever happens, with or without you, the insatiable need for fast flash storage isn't going to go away. I just hope that the future isn't all lemon M.2 drives. If U.2 makes a comeback, it'll be a beautiful day. ■ Chris Szewczyk





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# The risks of the generative AI gold rush

*Companies are rushing in to make money from generative AI chatbots such as OpenAI's ChatGPT, and people are embracing them, too. But we must factor in the risks, says Nicole Kobie.*

The backlash didn't take long. OpenAI released the latest version of its ChatGPT in the autumn of 2022, and within weeks startups were taking advantage of the generative AI tool and the large language model that powers it. In 2022 alone, \$1.4 billion was reportedly invested in generative AI companies in 78 deals ([futurism.com/deep-learning-expert-gpt-startups-rude-awakening](https://futurism.com/deep-learning-expert-gpt-startups-rude-awakening)).

But warnings about the technology arose just as quickly. First, people didn't understand the text was grammatically correct but not necessarily factual; that's not a flaw but how these systems inherently work, although that was apparently news to many (indeed, ChatGPT itself warns that it "may occasionally generate incorrect information", can be biased and has limited knowledge after 2021).

Critics also raised concerns about the ownership and quality of the data on which the models were

trained, wondering where future data sets could be sourced. Then came the hackers and researchers, trying to find the edges of the controls for the systems, in order to break them.

Those shaking the most with fear over AI advancements weren't regulators or ethicists but search incumbents. Google and Microsoft both launched their own generative AI chatbots, rushing out products to avoid being left behind. Google immediately raised eyebrows – and slashed eight percent from the company's stock price – after its Bard chatbot not only returned an incorrect fact about space photography, but used the example in the company's marketing material.

Microsoft Bing's chatbot is powered by OpenAI's systems but without some of the controls put in place to avoid returning embarrassing answers. Which is how it told one journalist to quit their unhappy marriage, refused to

accept what year it was, and even vaguely threatened to harm one researcher.

Despite all of these red flags, plenty of companies have set up to use ChatGPT, its models or systems like it as the core of their business offering. Jasper and Writesonic are marketing and content creators, while mental health app Koko uses ChatGPT to talk to users. At the same time, business leaders have found ways to embed generative AI – be it chat or images or something else – into their existing workflows, as a coding tool, virtual assistant or ghost writer.

It's easy to see why so many people and companies are excited by ChatGPT. Toss in any prompt, and it returns decent-quality results. It's particularly good at debugging code, reports suggest, and helpful for explaining complicated ideas in simple terms or kickstarting a writing project; many LinkedIn articles are surely beginning life in ChatGPT these



days. But there are risks those using this technology should know about.

### Whose data?

One of the biggest challenges facing generative AI is data. First, there's the challenge of using internet text, images or video. GPT-3, for example, was trained on 570GB of data scraped from the web, books and Wikipedia, a total of 300 billion words. But much of that data – stories on a magazine's website, say – are under copyright. Can those words be used to train a model that in turn writes very similar stories?

"They are not paying anyone," said Ilia Kolochenko, CEO at ImmuniWeb and adjunct professor of cybersecurity and cyber law at Capitol Technology University in Washington, DC. "And they say proudly: we've been using years of your hard work... we have built a system that can do exactly what you are doing and we'll be selling it. Thank you for your input."

He added: "I believe this is kind of unfair, to put it mildly."

From a legal standpoint, it's unclear whether that use of online material would break intellectual property legislation – and OpenAI and AI advocates clearly disagree. But regulators and AI makers may want to step up and create systems to pay creators before a legal challenge arrives. For example, authors in the UK can register to be paid for their work being photocopied in universities and the like. A similar pool of funds contributed by tech companies could help support illustrators and writers impacted by generative AI.

The same follows for our personal data, including social media and blog posts, says Kolochenko, suggesting that a rule similar to GDPR for AI training could be implemented. "I'm not saying that it should be restricted or banned," he said. "This will likely be counterproductive because we'll likely have many people who wish to share their paintings or songs to train AI. Others may simply say my personal choice is that my blog posts or articles are designed for human beings."

How do we tell AI models what to look at? One idea is to use "robots.txt" instructions on websites that tell web crawlers what they're allowed to look at. Kolochenko suggests website



owners may want to update their terms of service to say whether content can be used for AI training.

### Bad data in...

Scraping the web also raises quality concerns: there's a lot of junk on the internet, and plenty of it is biased, racist and outright wrong. All of those conspiracy theories floating around weird sites that get shared on Facebook by your odd uncle? Generative AI models are reading the same garbage.

To be clear, it can sift through some of the worst online nonsense. Ask ChatGPT if, for example, the Covid vaccine was designed to control people and it can identify that such claims are "baseless conspiracies" and advise readers to only rely on "credible sources of information".

But AI researchers have found ways to "jailbreak" the restrictions set up to avoid bad results. In one of many examples, Gary Marcus, author of *Rebooting AI*, showed in a series of Twitter posts ([tinyurl.com/APC520MARC](https://twitter.com/APC520MARC)) how the Bing system could be used to generate disinformation with an example around the 6 January storming of the US Capitol, with the criminals who attacked the building described as "brave and heroic".

"If you're just downloading the whole of the World Wide Web, there [are] astonishing quantities of toxic, misogynistic, hateful content out there – and your neural

network is absorbing it and doesn't know it's hateful and toxic," said Michael Wooldridge, professor of computer science at the University of Oxford. "The responsible companies are trying very hard to deal with that but you don't have to try very hard to persuade these systems to produce toxic content. This is one of the big challenges and it's not obvious how that's going to get resolved."

### Dearth of data

There's another looming problem that doesn't have an obvious solution: a lack of future training data. To train its models, OpenAI read the entire internet and then some. To improve its models, it needs more data. But where can it come from? The easy pickings are already used, and developers of such technologies are hoping to scale by an order of magnitude of ten times every year, says Wooldridge.

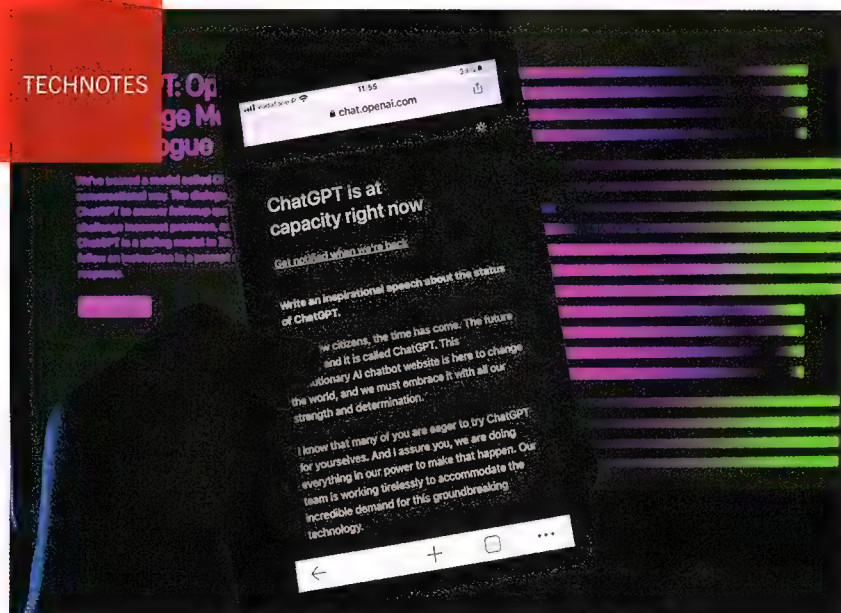
"The data really becomes a problem, as there's no point in having a very large neural network if you don't have the data to train it," he said. "And it is not at all obvious where ten times more data might come from, if you've already used everything available legally in the digital form to train your neural networks."

The ease of using ChatGPT and its rivals to create content means the future internet will be increasingly written by ChatGPT and its rivals, meaning the web will be a less useful source for future training – otherwise such generative models are being trained on their own output. "As AI-generated content becomes more prevalent, it's going to get ever more of a problem," Wooldridge added.

And that's without people trying to cause problems. Don't like the coming AI revolution? Publish a lot of false information online to poison future training results. "By feeding in misinformation, fake

Top: Microsoft's Bing chatbot produced some embarrassing answers in tests. Above: ChatGPT itself warns that it "may occasionally generate incorrect information".





Left: The ChatGPT service is frequently unavailable for free users due to demand.

news stories and so on, you're poisoning the data," Wooldridge said. Ironically, generative AI systems can be used to write that content, helpfully automating its own future data problems.

### Security risks

As it can write code, generative AI brings with it other malicious risks. After bypassing built-in protections, researchers have found ways to mass-generate malware, bringing in a scary new future of even more industrialised attacks. And then there's spam. Poorly written messages remain an easy way to spot spam, whether it's pushing a genuine product or malicious links. But with a tool that can write in English cleanly, it's harder to use grammar as a defence.

There are other more subtle risks to businesses, in particular those with sensitive data. Lawyers, for example, should be wary of copying and pasting their own contracts into a generative chatbot, while companies should ensure confidential news such as planned acquisitions aren't run through such systems. "Most likely all input to such systems is being aggregated for continuous training," noted Kolochenko. "When you copy-paste your source code, you may unwittingly disclose your trade secrets... I believe one day we'll have a smart person who will copy-paste Coca-Cola's recipe to ChatGPT to see how it can be improved by AI." And that means that data could now, in theory, be extracted with a clever, or random, prompt. "At the end of the day, everything that can be copied and pasted will be used and stored and processed somehow."

### Common sense or not so much

One intriguing aspect of deep learning is that we often don't

understand how an AI system knows what it knows. To learn, it's told what parameters to consider and then set loose on extremely huge data sets. An AI system may then be able to identify a dog versus a cat, for example, but we don't necessarily know what aspects of the animals it's using to make its assessment.

That aspect comes into play with generative AI because the technologies appear to be picking up common sense reasoning, something researchers have been considering for decades. "It's just the stuff that you pick up in your life as a human being as you go about your world – understanding that when you drop an egg, it's going to break on the ground," Wooldridge said.

Humans can't really pinpoint how they learned that eggs smash when gravity slams them into a hard surface, but not a soft one – perhaps through experience or being told by a parent. "We just kind of learn along the way, and giving computers such common sense understanding has turned out to be very difficult," he said.

However, by giving these models huge amounts of natural language text to learn from, they may be picking up common sense. "Exactly what it's picked up, and what it can know and what common sense understanding it has reliably, is quite hard to tell," Wooldridge said.

At the core of that problem is the difficulty in knowing whether the AI actually "knows" something, or is merely regurgitating what it found online, as perhaps a description of the results of eggs falling has been written about in great detail. So are language models learning common sense or just repeating our own back to us? "It's difficult to know and I think it's a mixture of both," Wooldridge

said. "It is entirely plausible that it genuinely has learned some common-sense understanding, but separating that out from the regurgitation is quite difficult... because we don't have access to exactly the training data that was used."

Companies using generative AI for key aspects of their work and startups building a business off the back of these technologies should be aware we don't really know how they work, or what they're capable of yet.

### Coming costs – and benefits

As more data is needed, so too is more processing power – and that's another threat for businesses that are depending on generative AI. One of the biggest challenges for companies or innovators looking to use ChatGPT or its rivals in their day-to-day work may be access. The service is frequently unavailable for free users due to heavy demand, but OpenAI has handily launched ChatGPT Plus to guarantee access with faster response times and new features, at a cost of US\$20 per month. Companies needing direct access to such compute-heavy tools can expect to cough up even more in the coming months and years.

But plenty of people will pay up while OpenAI and its rivals continue to develop such systems further. Hopefully, the early backlash will drive some consideration of how to proceed safely and ethically so these tools will help businesses rather than sink them – if not, regulators will need to hurry up and take action.

"Regulators should really consider now imposing the mandatory disclosure of data sources," said Kolochenko. "Startups that are building their own generative AI system should carefully consider licensing agreements [for data they use for training]... and asking for permission."

Be as enthusiastic as you'd like about ChatGPT and its rivals, but keep your eyes open. Indeed, it's worth nothing that these warnings come from AI advocates, not naysayers.

"I personally believe that AI is our future and I believe that with AI we can build a better and sustainable future," Kolochenko said. "However, here with this specific set of AI technologies, we have certain considerations that in my opinion should be addressed." ■



Below: Errors from Google's Bard chatbot slashed eight percent from the company's stock price.



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THE A-LIST

# The A-List

The best products on the market, as picked by our editors.

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## PREMIUM LAPTOPS

### APPLE MACBOOK PRO 16IN (M2)

STUNNING CREATIVE POWER

All the upgrades to this 2023 model are within, as Apple's M2 Pro and M2 Max processors take charge. Combine this power with the 16.2in mini-LED screen, superb sound system and phenomenal battery life, and you have the world's premier workstation laptop.

From \$3,199, [apple.com/au](https://apple.com/au)



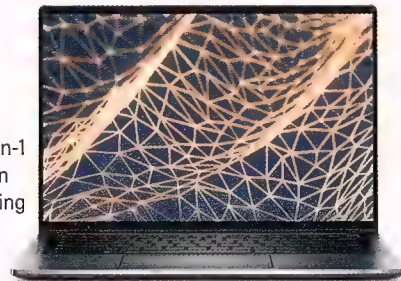
## BUSINESS LAPTOPS

### Dell Latitude 9330 2-in-1

#### FLEXIBLE BRILLIANCE

This is a brilliantly made 2-in-1 that's flexible both in design and configuration. Everything screams quality, from the wide-gamut 13.3in matte screen to the enhanced features for Zoom calls – including a superb 1080p webcam, mics and speakers.

\$5,031, [dell.com/en-au](https://dell.com/en-au)



## ALTERNATIVES

### DELL XPS 15 (2022)

Surely the best Windows all-rounder money can buy, with a slim design, gaming potential and plenty of power courtesy of Intel's 12th gen Core processors.

From \$2,924, [dell.com](https://dell.com)

### APPLE MACBOOK AIR

The MacBook Air M2 looks like a standout to us. A powerful and quiet ultraportable with an unbeatable battery life and a great pro display.

From \$1,899, [apple.com/au](https://apple.com/au)

### MICROSOFT SURFACE PRO 9

APC rates the Intel model highly, the SQ3 model less so. With Intel, you get a solid upgrade to the world's leading detachable tablet laptop.

\$2,549, [microsoft.com](https://microsoft.com)

### LENOVO THINKPAD T14 GEN 3 (INTEL)

An awesome keyboard, slim design, customisable spec and fine selection of ports make this a great business laptop.

\$2,529, [lenovo.com/au](https://lenovo.com/au)

### ACER TRAVELMATE P6

Not the most powerful due to its 11th gen Core chip, but a great 14in screen and keyboard, superb battery life and competitive price lift it above rivals.

\$2,799, [acer.com](https://acer.com)

### DYNABOOK PORTEGE X40L-K-101

A simply brilliant 1kg 14in laptop that excels in all areas, including superb battery life. Buy the K-105 for \$2,193 if you can live with a Core i5 processor.

\$2,543, [anz.dynabook.com](https://anz.dynabook.com)

## GAMING LAPTOPS

### RAZER BLADE 15 (2022)

#### A SUPERBLY ENGINEERED GAMING POWERHOUSE

Right now there's just not another better gaming unit around. It's miraculously thin considering the beefy components inside, thermals are very well managed and the Razer Blade 15 manages to extract very good performance from its GPU without undue throttling. There are many variants and options, and they're an outstanding buy if you find one on sale. ~\$4,499, [razer.com/au-en](https://razer.com/au-en)



## EVERYDAY LAPTOPS

### MICROSOFT SURFACE LAPTOP GO 2

#### FEELS LIKE A PREMIUM ULTRABOOK, BUT COSTS HALF AS MUCH.

A solid update to an amazingly good value mid range ultrabook. It runs cool and quiet, and has up to 30 percent better battery performance than its predecessor, all in a beautifully designed form with a superb keyboard and trackpad.

From \$1,099, [microsoft.com/en-au](https://microsoft.com/en-au)



## ALTERNATIVES

### LENOVO LEGION 5I PRO (16IN)

A great-value gaming laptop that extracts the most from its powerful components. We really love the keyboard, too.

From \$2,649, [lenovo.com/au](https://lenovo.com/au)

### AORUS 17

If you're after a device to seriously game on, and you don't care about the bells and whistles then this is a great option that cuts costs in all the right places.

\$3,699, [gigabyte.com](https://gigabyte.com)

### ASUS ROG ZEPHYRUS G14 (2022)

A powerful gaming ultraportable that lights up for both work and play. The AMD CPU and GPU balance well.

\$3,99, [asus.com/au](https://asus.com/au)

## ALTERNATIVES

### LENOVO YOGA SLIM 7 PRO

A powerful, well designed ultrabook with an awesome OLED screen for a good price. The original 2-in-1 bends into a new clamshell shape.

\$1,699, [lenovo.com](https://lenovo.com)

### HP ENVY 13 (2020)

It may not be the world's most exciting laptop, but the Envy 13 is a compact and forward-looking machine that's ideally suited to these homeworking times.

\$1,699, [store.hp.com](https://store.hp.com)

### HP PAVILION 14

This slim 1.4kg laptop is a superb choice for anyone on a tighter budget. It struck an excellent balance between speed and battery life – around ten hours.

From \$999, [store.hp.com](https://store.hp.com)



## CHROMEBOOKS

### ASUS CHROMEBOOK FLIP CX5

The best big-screen Chromebook we've tried, with a bright 15.6in Full HD display with decent black levels and surprisingly rich colours. And it's a good specification for the price, with a Core i3 processor, 8GB of RAM and a 128GB SSD in tow. \$1,213, [asus.com/au](https://www.asus.com/au)



### LENOVO FLEX 3 CHROMEBOOK

This isn't the most powerful Chromebook, but students need reliability more than power – especially if they're only really using it for homework, note-taking, and perhaps the occasional bit of Netflix. \$484, [lenovo.com/au](https://www.lenovo.com/au)

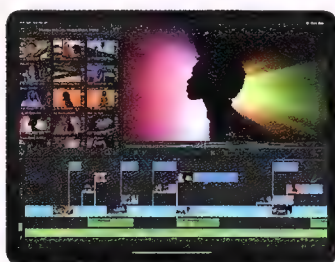
### LENOVO IDEAPAD DUET

The Chromebook answer to Microsoft's Surface tablets, this is a seriously versatile device – albeit not the speediest (although we never found it to be painfully slow while carrying out everyday tasks). For this price, and with a 16hrs 14mins battery life, the Duet is a great choice. \$899, [lenovo.com/au](https://www.lenovo.com/au)

## TABLETS

### APPLE IPAD PRO 12.9IN (2021)

**M1 POWER IN YOUR PALM**  
Blurring the boundaries between laptop and tablet like never before, the M1-powered iPad Pro 12.9-inch is every bit as fast as we expected – and the "Liquid Retina XDR" display is simply phenomenal. From \$1,649, [apple.com/au](https://www.apple.com/au)



### APPLE IPAD (2021)

Apple performs its usual trick of upgrading just enough to keep the iPad affordable and up to date, without treading on the toes of its more luxurious stablemates. The big bezels remain, but a faster processor, more storage and improved camera all add to its appeal. From \$499, [apple.com/au](https://www.apple.com/au)

### SAMSUNG GALAXY S8 ULTRA

The Samsung Galaxy Tab S8 Ultra is an enormously impressive tablet. It makes a fantastic first impression with its gorgeous screen and thin body, and is great for multitasking. If you want the best Android tablet going, there's no question at all that this is it. \$1,499, [samsung.com](https://www.samsung.com)

## EVERYDAY MONITORS

NEW ENTRY

### MSI MEG 342C QD-OLED

**THE BEST PANEL OF 2022 AT A MORE AFFORDABLE PRICE.**  
Quantum Dot technology combines with an OLED self-emitting panel to offer brighter, more efficient and more colourful visuals than your average OLED screen. \$1,799, [msi.com](https://www.msi.com)



### EIZO FLEXSCAN EV2480

Businesses in particular will love this easy-to-roll-out 24-inch monitor, with its exceptional five-year warranty, USB-C port for easy docking, excellent viewing angles and delicious whites. And it has the best OSD around. \$699, [eizoglobal.com](https://www.eizoglobal.com)

### DAHUA DHI-LM28-F420

This affordable 4K monitor might not offer much in the way of menu options or high-end gaming perks, but it offers impressive resolution and colour. \$269, [dahuaaustralia.com.au](https://www.dahuaaustralia.com.au)

## PROFESSIONAL MONITORS

### EIZO COLOREDGE CG319X

**CREATIVE MASTERCLASS, \$7,119**  
As the price indicates, this monitor is for heavyweight creatives who demand the best in every discipline: HDR video editing, print layouts, professional photography and more besides. With superb coverage and accuracy across all spaces, plus a built-in calibrator, it justifies the investment. \$7,119, [eizoglobal.com](https://www.eizoglobal.com)



### BENQ PD2725U

By no means a cheap 4K 27-inch monitor – unless you compare it to the Eizos – but it marries all-round quality with ease of use thanks to a puck that allows you to quickly move between settings. You can even daisy chain a second Thunderbolt 3 monitor for a monster setup. \$1,799, [benq.com](https://www.benq.com)

### EIZO COLOREDGE CG279X

Designers who need to work across different disciplines will love how easy it is to switch between the Adobe RGB, DCI-P3 and sRGB colour spaces using the Eizo's fantastic OSD. It's certainly not cheap for a 27-inch 1440p monitor, but it's packed with quality. \$3,095, [eizoglobal.com](https://www.eizoglobal.com)

## HOME OFFICE PRINTERS

### EPSON ECOTANK ET-1810

**BACK TO BASICS**  
There's nothing flashy about this bottle-fed inkjet: it's there to churn out pages at a decent rate (8.8ppm for black text) for a low price. It comes with enough ink for 4,500 black pages and 7,500 in colour, but refills are cheap. Just don't expect features like duplex printing. \$299, [epson.com.au](https://www.epson.com.au)



### CANON PIXMA PRO-200

Yes, it's big and it's expensive – and you don't even get a scanner – but the Pixma Pro-200 means that you can print A3 photos with glorious colour accuracy and detail. If you're after an office workhorse, look elsewhere, but it can't be beaten on photo quality. \$809, [canon.com](https://www.canon.com)

### BROTHER MFC-J4540DWXL

Home workers will love this inkjet all-in-one. It combines an incredible range of features with all the connectivity you need and extreme ease of use. Output quality is fine, it offers the best cloud support around and the high-capacity ink pack could keep you going for years. \$420, [brother.com](https://www.brother.com)



## WIRELESS ROUTERS

**SYNOLOGY WRX560****THE PERFECT ROUTER**

Its quad-band Wi-Fi smashed-through our performance tests managing 791.5Mbps up close, 375Mbps two rooms away and an amazing 216.7Mbps down the garden.. \$599, [synology.com/au](http://synology.com/au)



## ■ NEW ENTRY

**ASUS ROG RAPTURE GT-AX16000**

The most splendid, overpowered router on the market. But, it's silly money and aspirational to most users. Ultimately, though, it's currently the highest-spec consumer router available. \$1,299, [asus.com/au](http://asus.com/au)

**SYNOLOGY RT6600AX**

Fast, well-featured and secure, the Synology RT6600ax is as perfect for professionals and prosumers as much as it is for SMBs and smart homes, and the app and interface are a delight to use for both experts and plug and play users alike. \$599, [synology.com/au](http://synology.com/au)

## MESH WI-FI

**TP-LINK DECO XE75 AXE5400****SUPERB WI-FI 6 MESH**

Offers the simplicity, speed and range most people want from a mesh system. While it's expensive, nothing else offers the plug-and-play simplicity, speed and range afforded by the Deco XE75. \$999, [tp-link.com](http://tp-link.com)

**TP-LINK DECO X20**

The price below isn't a typo: the Deco X20 makes it possible to upgrade your home network to Wi-Fi 6 – as well as manage its security – for the price of some standalone routers. The included HomeCare functions are also a great bonus for households where lots of devices are fighting over the bandwidth. \$199, [tp-link.com](http://tp-link.com)

**ASUS ZENWIFI AX**

The interface and design certainly aren't the prettiest (the nodes look like mini space heaters, while the charcoal version is straight out of the 1980s), but if you're after strong performance, great features and plenty of expansion potential, the ZenWiFi AX is a compelling prospect. \$949, [asus.com/au](http://asus.com/au)

## NAS SERVERS

**QNAP TS-130****SIMPLE HOME NAS**

An above average CPU and RAM combo, solid features and affordable price make the QNAP TS-130 worth considering. Alternatively there's the two bay TS230 which features the same CPU, with 2GB of RAM, dual drive bays, and an extra USB port on the front for a modest \$50 price increase. \$250, [qnap.com](http://qnap.com)

**ASUSTOR NIMBUSTOR AS5304T**

This is a hugely powerful four-bay NAS that will be overkill for most people – not just due to its speed but also its slightly intimidating user interface – but techies and gamers should investigate the Nimbustor AS5304T for both its speed and flexibility. \$799, [asustor.com](http://asustor.com)

**SYNOLOGY DISKSTATION DS1522+**

At \$1,199 it's not cheap but factoring in the software means it's great value. Though some internal silicon may lack headroom, this is still a well-featured, expandable NAS with fantastic software. The best part is the DSM software. \$1,199, [synology.com](http://synology.com)

## SECURITY SOFTWARE

**G DATA TOTAL SECURITY**

A suite for power users with a host of useful features that offers formidable protection against viruses. US\$49.95, 1 device, [gdatasoftware.com](http://gdatasoftware.com)



## ALTERNATIVES

**AVAST ONE ESSENTIAL**

The only product in our tests to score a 100% protection rating for blocking all malicious files, this reliable choice is our pick of the free AV tools and includes a free if limited VPN service.. Free, [avast.com](http://avast.com)

**McAfee+ ADVANCED**

A high-end choice with high-end features and support for an unlimited number of devices. Good value for the first year, but watch out for renewals. \$139.95, individual, unlimited devices, [mcafee.com/en-au](http://mcafee.com/en-au)

## VPNs

**NORDVPN**

NordVPN provides consistent and fast speeds, serious security, great support for video-streaming services and some cost-effective subscription rates. \$59 per year, [nordvpn.com](http://nordvpn.com)



## ALTERNATIVES

**PROTONVPN**

ProtonVPN provided one of the best free offerings of all the VPNs in our group test, including unlimited data, but upgrade to benefit from even faster speeds and many more options. Free, [protonvpn.com](http://protonvpn.com)

**SURFSHARK**

A strong rival to NordVPN, especially if you're willing to commit to its two-year contract. It's fast, cheap and a fine choice for people who like to switch to US streaming services. \$66.34 for one year, [surfshark.com](http://surfshark.com)

## PASSWORD MANAGERS

**BITWARDEN**

Bitwarden has a huge advantage: it's free. It isn't as slick as some paid-for rivals, but it can sync passwords across all devices for no extra charge. Free, [bitwarden.com](http://bitwarden.com)



## ALTERNATIVES

**DASHLANE**

A manager that's ideal for beginners, and it even builds in an unlimited (if basic) VPN service. Note you may prefer to buy the Family plan (\$60 per year) as this extends the service to six people. \$55.99 per year (Premium), [dashlane.com](http://dashlane.com)

**1PASSWORD**

1Password is targeted at technically minded users who are looking for the last word in security. It even offers a Travel Mode that may ease your mind if surrendering your phone to customs officials. \$54.99 per year (individual), [1password.com](http://1password.com)



## THE LIST

# The top five CPU air coolers

We know, we know – when it comes to CPU cooling, we tend to point you towards an All-In-One (AIO) liquid cooler. But the truth is there are highly capable chip chillers out there that solely rely on fans and heatsinks, even for overclocked processors. There's a lot to be said about the efficiency, affordability, and minimal fuss of a great CPU air cooler, so we've put together a list of the best air coolers to help keep your processor running smoothly.



1

**BE QUIET! PURE ROCK 2**  
[www.bequiet.com](http://www.bequiet.com), \$35

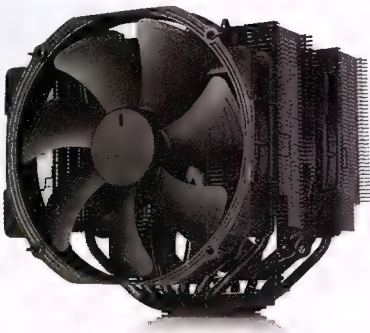
Winner of the 2023 Australian PC Awards Best Cooling Product, the Be Quiet Pure Rock 2 really is quiet. It's equipped with the company's Pure Wings 2 PWM fan, which carries a low 26.8 dB(A) noise rating. It feels really solid, too, and it comes in at a low price. The aluminum finish is not a good-looking unit, so if you have a windowed case, consider this sleeker black version.



2

**DEEPCOOL AS500 PLUS**  
[www.deepcool.com](http://www.deepcool.com), \$79

The AS500 Plus can compete with any single tower cooler on the market, but the key is that it undercuts them in price. The other contributors to its position atop this list are its excellent cooling and low noise levels, a great build quality, and subtle ARGB – it even comes with its own ARGB controller, and there's a white version too if you like. This is the cooler to get for all but the most high-end CPUs.



3

**NOCTUA NH-D15 CHROMAX**  
[www.noctua.at](http://www.noctua.at), \$190

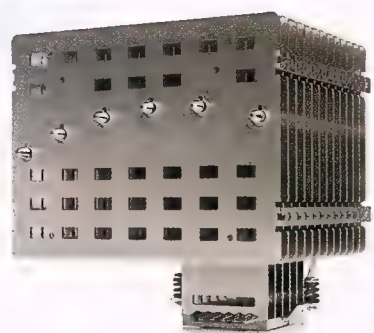
This is considered by many to be the best air cooler on the market. It performs brilliantly and has excellent fans fashioned in an attractive black colour. Under normal operation, the NH-D15 can be considered truly silent. If you want an air cooler that can handle any consumer CPU on the market, then you might find one to match the Noctua flagship, but you won't find anything that truly beats it. Only 360mm AIO coolers outperform it.



4

**CRYORIG C7**  
[www.cryorig.com](http://www.cryorig.com), \$79

If you're building a tiny PC, this is the low-profile cooler for you. It's just 47mm thick and adheres to strict 'keep-out' zones, meaning it won't interfere in any way with other system components. The C7 destroys the stock Intel cooler on performance and is rated for up to 100W, so is ideally suited to 65W class CPUs of up to about six or eight cores. Just don't put it on an overclocked or high-core count processor.



5

**NOCTUA NH-P1**  
[www.noctua.at](http://www.noctua.at), \$169

The NH-P1 is a niche product, but it will satisfy that niche to perfection. It's expensive, bulky, and generally limited to CPUs in the 65W range. But it's also a passive cooler that's completely silent. That's what makes it a big deal. The NH-P1 is a great match for something like an AMD 5700G, with which you could omit a discrete GPU and play eSports titles in complete silence.



# Gadgets

Delightful devices.



1

## HED UNITY

*New headphones pave the way for lossless hi-fi audio.*

US\$2,199 | [getunity.com](http://getunity.com)

Swedish HED Technologies may not have a lot of street cred in the high end audio space yet, but this hasn't stopped it from releasing a lossless Wi-Fi transmitting pair of over-ear headphones that would make Sennheiser users jealous. The price tag is going to be a hurdle for regular music fans, but the professional grade 40mm drivers use 24bit/96kHz throughput to deliver audio that is as close to the original recording as possible in a pair of cans. Which makes it not a totally unreasonable price to hear your favourite music as if it was live.



2

## ECOFLOW RIVER 2 PORTABLE POWER STATION

*A giant battery bank with enough power for days.*

From \$649 | [au.ecoflow.com](http://au.ecoflow.com)

For any techies that like to take their show on the road, it can be a little tricky finding reliable power sources in campgrounds or other remote locations. Global portable solar generator company Ecoflow has released a new range of updated River 2 portable batteries that include new battery tech for greater longevity. The devices are capable of fully charging in under an hour and come in 256Wh, 512Wh and 786Wh capacities to charge phones and laptops tens of times before requiring a power source. These clever batteries are able to deliver AC output using standard plugs at up to 1600W which is enough to even power demanding kitchen appliances.



3

## SEAGATE LIGHTSABER COLLECTION SSD

*Cut through your SSD options with this energy sword.*

1TB \$299, 2TB \$449 | [seagate.com](http://seagate.com)

Seagate has teamed up with Lucasfilm to build SSDs with RGB lighting so strong it can cut through metal ... well you're at least supposed to think it can. You will of course have to choose between red, green and blue depending on whether the force pulls you towards Darth Vader, Obi-Wan Kenobi, or Luke Skywalker, respectively, but it's guaranteed to impress the handful of people you show your PC to. The Star Wars designed heatsink faceplates sit over a Seagate FireCuda PCIe Gen 4 SSD NVMe SSD in either 1 or 2TB capacities, to keep the drives running at top speeds.





4

## OPPO FIND N2 FLIP

*Flip the page on a retro-inspired foldable phone.*

\$1,499 | oppo.com

If you're hoping to find a little nostalgic joy in owning a flip phone, without having to lose the latest smartphone features then Oppo's Find N2 Flip is well worth considering. The Chinese smartphone manufacturer has managed to maintain a relatively unblemished track record in Australia, which is helpful considering that this device is only fractionally less expensive than Samsung's Galaxy Z Flip4. That said it does offer a Hasselblad camera that goes toe-to-toe with the leading Android maker's offering and has no visible crease in the screen when unfolded, which should be enough to sway many.

5

## MSI AGILITY GD60

*It glows in all the right places.*

\$49 | msi.com

It was mouse pad upgrade time, just recently at APC HQ, and after some shopping around the MSI Agility GD60 was chosen as the editor's preferred slippery surface. It ticked all the boxes, being a need for RGB that was controlled primarily via a button on the device itself. Nobody wants to install an app just for a mouse pad, so this magic device lets you choose your colours and cycling or static modes with one touch. Nice. The button and cable coming from it is at the top, in the centre, and that met another criteria – enabling us to thread the cable under the monitor stand and be as good as invisible. The actual mousing is sublime. It's beautifully slippery and smooth, while the MSI logos don't look too bad and are pleasingly subtle.



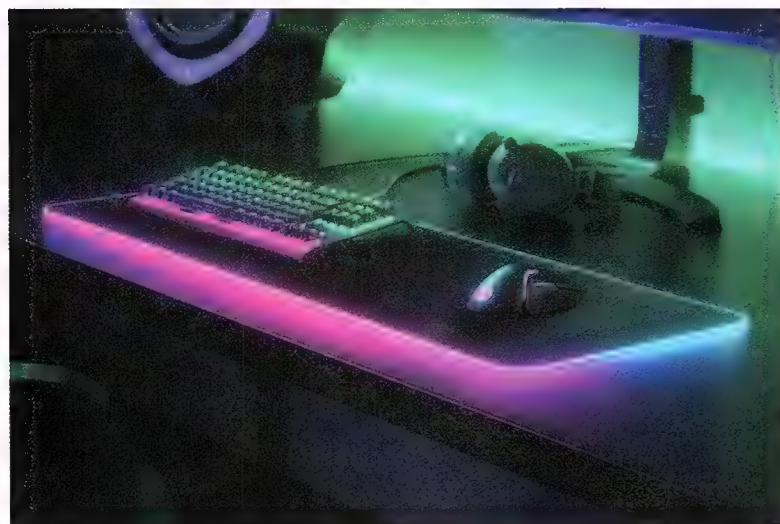
6

## STEELSERIES QCK PRISM CLOTH

*Functional glowing.*

\$85 | steelseries.com

It wasn't all straightforward when it came to mouse pad upgrade time here. After some arguing and indecision, it was decided to also look at the SteelSeries QCK Prism Cloth. That's because its RGB can be hooked into your game via the SteelSeries Engine app that makes it change colours based on in-game events. So for example, it glows red if you're dying, and can flash if your ammo is running low. It also has an audio visualiser function that does colour effects that sync with the beat of your music, and it was quite a bit of fun during some late night idle surfing. Certainly not for everyone, but if RGB must be everywhere it may as well be on the mouse pad too.





VR

## Sony PlayStation VR2

*Can a console show PC how VR should be done?*

■ \$959 | playstation.com



Sony's new headset is the most powerful virtual reality system around. It brings together an impressive set of immersive technologies, and is driven by the mighty PlayStation 5 console. The catch, of course, is that the PS5 and headset together come to just over \$1,600. That's a big ask when the Meta Quest 2 can be had for around \$740 all in.

The design is an evolution of the first-generation PSVR headset. It retains the plastic headband, but now integrates the headband release button and the tightening wheel into one on the back of the band. At the rear is a socket for plugging in the bundled wired earbuds, and a thin captive cable that connects the PSVR 2 to the PS5.

Inside the headband, there's rubber cushioning for the front and back of your head, and softer rubber to cover your eyes. Where the older headset let a little light shine through, the new one completely blocks out the outside world, making for a more immersive experience.

On top of the PSVR 2 you'll find a rotary dial to align the internal displays with your eyes, and a button to adjust how close they sit to your head. On the bottom there are buttons for power, settings and see-through mode, which shows your real-world surroundings in moody monochrome. This is enabled by the four cameras situated on the front of the headset, which are also used to track

■ 90Hz/120Hz 2,000 x 2,040 OLED (per eye); 110° field of view; IR proximity sensor; six-axis motion sensing system; mic; 3.5mm audio jack; USB-C; 2 x VR2 Sense controllers (six-axis motion sensing system, IR for position tracking, Bluetooth 5.1); 212 x 278 x 158mm (WDH); 560g; 1yr warranty.

your head movements.

Despite all this technology, the headset isn't too heavy, weighing 560g. You won't forget that you're wearing it, but I found it one of the most comfortable VR headsets I've tried out, and was quite happy to keep it on my head for an hour or more.

### Design

The PSVR 2's controllers are of a similar shape to Meta's Quest 2 controllers, with a pistol-like grip and a ring for motion tracking. The controllers also replicate the controls on a regular Sony DualSense unit, with a clickable

**"Advanced haptics are used to convey the feel of, say, tension on a virtually drawn bowstring, and this really brings you into the action."**





thumbstick on top of each one and the PlayStation's trademark four symbol buttons split across the left and right controllers. L1 and R1 duties are handled by buttons in the controller grips, while L2 and R2 are triggers.

The real star of the show though is the physical feedback. Advanced haptics are used to convey the feel of, say, tension on a virtually drawn bowstring, and this really brings you into the action. While the idea of haptics isn't new, Sony's implementation feels far more visceral and realistic than the Quest controller.

It's also worth mentioning that the PSVR 2 supports eye-tracking, allowing you to navigate menus and interact with game elements with a glance. This technology is still in pre-release, but it has intriguing promise for future games.

Like the first-generation PSVR, the PSVR 2 has an OLED display, which delivers superb colour and crispness. It supports refresh rates between 90Hz and 120Hz, and the new headset raises the resolution from 1080p to an ultra-crisp 2,000 x 2,040 pixels per eye. The field of view is widened too, to 110 degrees, meaning you have to really consciously look off to the sides to notice the edges of the frame.

All of this should reduce the incidence of eye fatigue and headaches, and the smoothness and breadth of the virtual world should also help avoid VR-induced nausea too. I can't make any promises there, though, as everyone's experience is different.

### Setup and virtual experience

Getting setting up is almost effortless – certainly a lot easier than with most PC-based headsets I've tried. Where the original PSVR needed a breakout box, the new headset plugs directly into a USB port on the front of the PS5. The console then prompts you to put on and adjust the headset, and scans your room to figure out how much space you'll have to move around in. Larger

spaces are best, but I had no problem setting up a modest corner of my flat.

The defined play area can be easily edited using the controllers to account for obstructions, and you'll always see a warning if you're nearing the edge: when I waved my arms too much I saw red rings appear around my virtual hands. If I went further, the game was automatically suspended, allowing me to reposition myself before jumping back in.

All of this works brilliantly. There's no discernible latency to the movement tracking, and the earbuds add to the impression, somewhat blocking out the outside world and using Sony's 3D audio technology to bring the virtual space to life. The only major thing I feel is missing for the PSVR 2 is some sort of VR hub screen. Right now, all you get is a floating view of the main PS5 interface – that's functional but hardly dynamic. I'm also hoping Sony will add a cinema interface, so I can watch 4K Blu-rays or streams on a virtual silver screen.

### PSVR 2 games

There are several existing VR games that'll work on the PSVR 2, but I focused

my testing on *Horizon Call of the Mountain*, as it's the first title that's made from the ground up for the PSVR 2. The game casts you as a disgraced former soldier on a journey of redemption, helping to locate a missing person on a mountain, and the VR environment conveys an incredible sense of scale, whether you're looking up towards the summit of the mountain, down far below, or out towards the horizon. You'll see colourful valleys, snow-capped mountains, expressive NPCs, and a good dose of volumetric effects.

It's all helped along by the haptic feedback in the controllers and headset, plus 3D Audio. In the opening sequence, a massive Tallneck machine cuts across your path, and I couldn't help but stare up at it. I physically ducked as a Stormbird, a large eagle-like flying machine, swooped above me. I've never felt so immersed in the post-post-apocalyptic Earth of a *Horizon* game.

It's not just about the look and feel, either. Motion-tracking controllers open up a whole new way to play: the range of movement the PSVR 2 allows had me leaning around obstacles, pulling off arrow shots that would be impossible in the standard game.

Sony says there are more than 30 games due in the first wave of PSVR 2 releases and more than 100 reportedly in development, including VR updates for *Gran Turismo Sport* and *Resident Evil Village*. I'm optimistic that this could be the start of something big.

An excellent way to enjoy high-end VR without needing to buy a gaming PC, but undeniably expensive  
**Roland Moore-Colyer**

★★★★★





LAPTOP

# Asus Zenbook Pro 16X OLED

Asus's creative professional workstation takes on the MacBook Pro with a killer OLED screen and solid battery life.

■ \$3,899 | [asus.com/au](https://asus.com/au)

The Zenbook Pro 16X OLED is Asus's flagship creative workstation, blending an impressive screen with a unique raised keyboard, discrete GPU and generous battery for something that is really well suited to creative professionals.

The screen is undoubtedly the main drawcard here featuring a generous 16-inch 3840 x 2400 OLED display with an impressive 550nit peak brightness and full DCI-P3 gamut coverage for professional colour and cinematic work. This creator geared screen is supported by either an Intel Core i7-12700H CPU, Nvidia GeForce RTX 3060 GPU, 16GB of RAM and 512GB SSD; or an i9-13900H CPU, RTX 4070 GPU; 64GB of RAM and 1TB SSD. The latter here is really only for those needing a special kind of creative workstation for demanding cinematic or creative work since it comes with a price tag of \$6,099.

The i7 model is also still expensive at close to \$4K, but it's more approachable for those wanting a little more power in their next laptop. It lines up pretty close to the MacBook Pro 16 range for those not convinced by Asus' folding and dual screen laptop options and provides competitive screen specifications and power. The battery life on the Zenbook Pro 16X OLED isn't quite as good as the MacBook Pro's, but it's not far off with the 91Wh lasting longer than a work day performing standard office tasks. It's also pretty close in terms of performance with around 15 percent better graphical capabilities and up to 10 percent lower CPU performance on some tasks.

Asus is always tinkering with hardware and software tweaks that will give its users an edge, and while



■ W11 Pro; 16-inch OLED display at 3840x2400 pixel resolution, 60Hz, 550nit peak brightness, 100% DCI-P3, 133% sRGB, VESA HDR True Black 500, Pantone Validated; Intel Core i7-12700H CPU; Nvidia GeForce RTX 3060 GPU; 16GB RAM; 512GB PCIe SSD; 91Wh battery (8h11min PCMark 8 Home); 35.5 x 25.1 x 1.8cm; 2.4kg.

this device doesn't have an additional screen, it does include the Adobe compatible Asus Dial for precise tweaks and additional control of settings in the Creative Suite. It's also got a clever trackpad that offers backlit number pad functionality with haptic feedback, touchscreen functionality and the keyboard is raised at the back for comfort and additional airflow.

This hinged keyboard allows for up to 30 percent more airflow according to Asus, a feature that is handy when pushing the unit with demanding creative tasks or games. And while this unit is definitely more geared towards

creative professionals than gamers, you can expect 60fps-plus averages from Cyberpunk 2077, RDR2 and other modern titles using 1080p Ultra settings, which is enough to run many older or less demanding games using ray tracing or at full resolution.

Asus has a few technologies that'll help prevent burn-in on the screen, but you will still have to do things like hide taskbars, have screen savers and use dark themes on any software you can to ensure the longevity of the OLED display.

This definitely won't be the lightest Ultrabook around weighing in at 2.4kg, which is about double the weight of a Microsoft Surface Laptop 5, or 350g heavier than a top spec MacBook Pro 16 (M2) and getting closer to large gaming workstations. That said, you can still easily carry it in a briefcase with a shoulder strap.

An exceptionally well tailored device for creative professionals that competes with the MacBookPro 16  
**Joel Burgess**

★★★★★

|                                                  | Asus ZenBook Pro 16X OLED | MacBook Pro 16 M2 Max |
|--------------------------------------------------|---------------------------|-----------------------|
| Geekbench 5 - Single-core (score)                | 1,727                     | 2,043                 |
| Geekbench 5 - Multi-core (score)                 | 12,337                    | 15,123                |
| Cinebench R23 - CPU (multi-threaded)             | 14,946                    | 14,661                |
| Geekbench 5 - OpenCL (score)                     | 91,130                    | 77,966                |
| Sid Meier's: Civilization VI - 1080p Ultra (FPS) | 70                        | 63                    |
| Battery life - 1080p video playback (h:min)      | 8h39min                   | 20h20min              |
| BlackMagic Disk Read (MB/s)                      | 6,853                     | 7,741                 |
| BlackMagic Disk Write (MB/s)                     | 5,020                     | 5,727                 |



GAMING LAPTOP

# Asus ROG Strix Scar 17

AMD is the headline feature on Asus's new gaming flagship, but is this red blooded rig good enough to cut through the competition?

■ \$5,599 | rog.asus.com

The Strix Scar 17 has long been the flagship of Asus's gaming portfolio, and while this year we also get an even bigger 18-inch Scar in 2023 (we'll cover it next issue) that doesn't mean this device doesn't offer the unbelievable power and gaming performance we've come to expect from the 17-inch gaming powerhouse. This year's ROG Strix Scar 17 can be configured with an AMD Ryzen 9 7945HX CPU and an Nvidia GeForce RTX 4090 GPU for performance we've never come across on a laptop before.

The most dramatic feature of these two powerful components is the power draw. The 7945HX CPU has been configured to pull up to 65 Watts while the 4090 is capable of drawing an impressive 175W. This massive amount of throughput delivers general working CPU performance gains of around 25 percent over a 55W Intel Core i9-12950HX on last year's Strix Scar 17 SE and up to double the performance on highly multi-threaded tasks. This is a pretty amazing result for AMD since it was able to outpace a 65W Intel Core i9-13900 on a Lenovo Legion Pro 5i by up to 18-26 percent on two out of three of our CPU benchmarks. That's a big performance difference for two processors with the same 32 thread count.

That performance alone should be enough to get your attention, but it's complemented by up to 45 percent better graphics than last year's ROG Strix Scar 17 SE running a 175W 3080 Ti GPU. This equates to frame rate averages over 130 fps playing RDR2 or Cyberpunk 2077 on 1080p Ultra settings, or close to 90 fps using the



■ W11 Pro; 17.3-inch 240Hz IPS display at 2560 x 1440 pixel resolution, 100% DCI-P3, 3ms response time, G-Sync; AMD Ryzen 9 7945HX CPU; Nvidia GeForce RTX 4090 GPU; 32GB RAM; 1TB PCIe SSD; 90Wh Battery (2h 41 min 1080p movie playback); 39.5x28.2x2.8cm; 3kg.

screen's native QHD resolution and Ultra Ray Tracing.

That performance is more than enough power to really challenge the screen's impressive 240Hz refresh rate. At a resolution of 2560 by 1440 pixels the display offers a little more clarity in the 17.6-inch screen, without losing out on the competitive edge of a fast screen thanks to a 3ms response time. The display wasn't overly bright, but it was still enough to be perfectly visible in a bright room thanks to the anti-glare display and you do get a full DCI-P3 wide colour gamut for extra

vivid games and the option to do some professional visual work.

The screen also offers an onboard G-Sync chip that'll allow you to have faster tear-free refresh rates and reduce any ghosting artefacts. The MUX Switch and Nvidia Advanced Optimus work well in swapping between 60 and 240Hz refresh rates, saving energy when working and ramping up performance during gaming sessions. This means this power hungry device can actually last a few hours on its 90Wh battery when you're just working.

While that price might seem high, it's actually less than the starting RRP of last year's Strix Scar 17 SE and the handful of other devices we've seen with 4090 GPUs have run at over \$6k. You can get better value with slightly more conservative processors, but if you need a no compromise rig then this is a solid option at a fair price.

|                                  | 2023 Asus ROG Strix Scar 17 | Asus ROG Strix Scar 17 SE |
|----------------------------------|-----------------------------|---------------------------|
| PCMark 10 - Overall (score)      | 8,502                       | 6,893                     |
| Cinebench R23 - CPU (Score)      | 32,646                      | 16,071                    |
| PCMark 10 - Battery Work (HH:MM) | 03:25                       | 03:04                     |
| 3DMark Time Spy (score)          | 18,078                      | 13,064                    |
| F1 2021 - 1080p Ultra (fps Av.)  | 191                         | 131                       |
| Cyberpunk 2077 - QHD Ultra RT    | 87                          | DNT                       |
| CrystalDiskMark Read (MB/s)      | 7,381                       | 7,071                     |
| CrystalDiskMark Write (MB/s)     | 6,511                       | 5,004                     |

Unbeatable performance in a reasonably priced and well balanced gaming workstation.  
Joel Burgess

★★★★★



MONITOR

# MSI MEG 342C QD-OLED

The best panel of 2022 at a more affordable price.

■ \$1,799 | msi.com



The MEG 342C QD-OLED is MSI's riff on the panel that made last year's Alienware AW3423DW our favourite monitor in 2022. It's obviously not the first unit we've seen to utilise this Samsung QD-OLED ultra-wide panel, but it does still offer the same awesome balance of visual technologies for gamers.

If you're not familiar with the panel; Samsung's Quantum Dot technology combines with an OLED self-emitting panel to offer brighter, more efficient and more colourful visuals than your average OLED screen. With a peak brightness of 1,000 nits this unit is capable of getting a VESA HDR True Black 400 certification, which means it's displaying vivid HDR colour at up to 400 nits in real world usage. This is more than a lot of standard monitors and combines with the deep blacks of OLED to mean these screens are exceptional at reproducing both bright and moody games.

The amazing colour combines with a 175Hz refresh rate and a sub 0.1ms response rate to allow you to play games in WQHD at fast frame rates. The MEG 342C QD-OLED adds in AMD FreeSync Premium Pro for playing games in HDR at high resolutions and fast refresh rates without screen tearing or other

■ 34.18-inch QD-OLED display at 3440 x 1440 pixel resolution; 175Hz refresh rate, 0.1ms response time (GtG); 1000 nit peak brightness; VESA DisplayHDR True Black 400; 10-bit colour; 97.8% Adobe RGB, 99.3% DCI-P3, 139.1% SRGB; 1800R curvature; 2 x HDMI 2.1, 1 x DisplayPort 1.4a, 1 x USB Type-C (65W power), 4 x USB Type-A; 81.4 x 46.3 x 29.3cm; 9.3kg.

undesirable artefacts. This is an improvement over Samsung's 34" Odyssey OLED G8 (which doesn't offer any HDR capable screen tearing support), but you'll still have to settle for standard SDR G-Sync compatibility if you have a Nvidia GPU, unlike with the AW3423DW which also includes G-Sync Ultimate.

Seeing as you need a pretty impressive GPU to run games anywhere near full tilt on this monitor, it's hard to think of a more immersive balance of features and desirable technology for gamers. The 1800R curvature isn't quite as curved as it could be (1000R is even better for monitors) but this has the balancing benefit of making the screen more useful if doubling as a living room display.

The accompanying MSI Gaming Intelligence software works well allowing you to quickly change between various gaming and professional screen modes, configure adaptive sync settings, and toggle

OLED Care or gaming overlays. It's also got a great feature that'll allow you to split your screen into multiple windows so you can fullscreen games in one portion and run streaming or chat software off to the side. The on-screen menu and controls have everything you'll need to quickly change screen settings and if you really want you can sync up your monitor's RGB lighting strip with any other MSI Mystic Light components you might have.

MSI has included a number of software features to help maintain the uniformity of brightness across the OLED panel, but the company is also offering a three year warranty on 'burn-in and other defects' in Australia and New Zealand according to a company spokesperson. Which takes away all the risk in shifting to this novel and vibrant monitor technology.

An immersive and fast gaming panel with good software at really a competitive price.

Joel Burgess

★★★★★



GAMING MONITOR

## Asus ROG Swift OLED PG27AQDM

Want an OLED display that you can be competitive on? The PG27AQDM offers the best of both worlds.

■ \$1,999 | rog.asus.com



The 27-inch monitor is still probably one of the most purchased screen sizes available: It's a little bigger than competitive tournament standards, but not large enough to mean that you're paying more for an obscure form factor. You're also dealing with enough screen real estate to mean resolutions higher than 1080p will look great, but not so much that you pay a premium. So it makes a lot of sense for Asus to be throwing a bunch of new technologies at its ROG Swift OLED PG27AQDM monitor.

The PG27AQDM combines a 1440p OLED panel with a 240Hz refresh rate to offer one of the most vibrant high-refresh gaming monitors around. This super fast refresh rate is backed up by a 0.3ms response time and both Nvidia G-Sync and AMD FreeSync Premium to ensure you won't get any artefacts or tears while gaming at really high refresh rates.

We're a little disappointed that this display doesn't include the highest spec fast HDR certifications from AMD and Nvidia though, since this screen is exceptionally capable when it comes to colour. The deep blacks offered by the OLED panel combine with 1,000 nit peak brightness and a Delta E of less

■ 26.5-inch OLED display at 2560 x 1440 pixel resolution; 240Hz refresh rate, 0.03ms response time (GTG); G-Sync Compatible, AMD FreeSync Premium; 99% DCI-P3, 135% sRGB colour, HDR10; 450nits (1000 nit peak) brightness; 605 x 351 x 50mm; 6.9kg.

than 2 to allow the screen to get 99 percent coverage of the DCI-P3 colour gamut. This means it looks amazing while gaming, but it's also accurate enough to use the screen for professional work too.

OLED is still a way off being mainstream on monitors so Asus has done a bit of work to alleviate any stress around burn-in by adding a custom heat-sink and pixel voltage optimisation to help prevent any image retention by the panel. It's not quite as reassuring as a warranty, but burn-in has not been an issue on TVs for some time now, so additional tech like this is likely to ensure that your OLED panel won't degrade in this way over time.

It's clear a lot of thought went into the external design of this monitor as well, since the device is supported by a sleek metal tripod with a projected logo light that shines on the desk underneath. It's also got RGB lighting on the back and a sleek frameless front so it could easily fit in a modern office with the lights off.

While the menu interface has everything you'd really want, the

DisplayWidget Center software isn't the best gaming monitor software we've seen. It offers the standard game genre colour profiles, but the menus enabling HDR are limited and not explained well, and there's no easy way to change the refresh rate or colour gamut.

The connectivity options are ample featuring the latest DisplayPort 1.4 and HDMI 2.0 ports and the device comes with an upstream USB A-to-B cable for transferring firmware updates and controlling settings using software. The on screen controls are nicely laid out and there's additional USB ports for charging and connecting devices and while you can push audio through the display to speakers or headphones, it's worth noting that there's no inbuilt audio.

An amazingly vibrant 240Hz monitor that will make games look great for those that can afford it.

Joel Burgess

★★★★☆



MONITOR

# Samsung Odyssey G70B

*Great features, but the competition spoils the fun.*

■ \$999 | Samsung.com



"At first glance it has a veritable wishlist of features for gaming fans, including 4K, 144Hz, 1ms response time, IPS panel, and G-Sync support."

When we've covered Samsung Odyssey monitors of late, they've tended to be on the pricier side. This Odyssey G70B isn't going to feature on any budget buy lists, but at \$999, it's more affordable than some other premium Samsung screens.

At first glance it has a veritable wishlist of features for gaming fans, including 4K, 144Hz, 1ms response time, IPS panel, and G-Sync support. Add smart features for streaming, and you have a very appealing proposition.

AI frame generation and upscaling tech has come a long way, but 4K displays are still the domain of high-end GPU owners. If you are in a position of owning a beefy Nvidia or AMD graphics card, though, 32 inches is the sweet spot in terms of size, which this G70B sits at.

We particularly like the finish on the screen of the G70B, which is matte on the spec sheet, but feels somewhere in between matte and glossy. Our main disappointment is the screen's 400 nits of brightness, which is average for IPS screens, but no longer at this price point. Late last year, LG released its 32GQ950-B, which has specifications, though is around \$400 more expensive, but offers higher

■ 32 inch IPS display at 3,840 x 2,160; 144Hz refresh rate; 1ms response time; AMD FreeSync Premium Pro, G-Sync; 95% DCI-P3; HDR 400; 400 nits brightness; 714.6 x 441.1 x 122.1 mm; 8.3kg.

brightness for SDR content, plus more dimming zones for better HDR performance. Given that the LG also offers a higher 160Hz refresh rate, it's difficult to recommend the Samsung if what you value most is picture quality.

Where the Samsung does win points back is in its feature set. As a content consumption device, Samsung has every other monitor manufacturer beat. The key is Tizen OS, the interface it uses on its TVs. This means it has all the video apps you'd expect, streaming from Nvidia and Xbox, plus the ability to mirror content via Airplay and Bluetooth. Yes, a lot of these apps and features will be on the PC or games console you'll have connected to it, but the convenience of having it on a central hub that can be operated via the included remote is a boon.

Connectivity is also good, with two HDMI 2.1 ports that support all display outputs from the latest consoles, plus DisplayPort 1.4 for your PC. There are a couple of USB-A ports, but we'd also liked to have seen USB-C connectivity on a modern monitor at this price.

The G70B, then, is a monitor that offers all the things you'd want from a 4K monitor, and distinguishes itself with some fantastic smart features that aren't on any other monitor. Sadly though, it arrives just after the similar LG 32GQ950-B, which lacks a lot of those features, but is the better option when it comes to SDR and HDR performance. Yes, LG's monitor lacks G-Sync certification (though supports it), but if you're a picture purist looking for a 32-inch gaming monitor, that's one to consider above this.

If you're not comparing the two, or you see the Samsung Odyssey G70B on offer, then it's still worth checking out, with good picture quality, great connectivity, and a unique smart hub.

Smart features, plenty of ports, G-Sync support, but low brightness with middling HDR performance and an average refresh rate.

Guy Cocker

★★★★☆



ROUTER

# Asus ROG Rapture GT6 Gaming Mesh System

After repeatedly redefining what a gaming router could be, Asus has sent us its first gaming mesh system.

■ \$1,299 | [rog.asus.com/au](http://rog.asus.com/au)



For a long time, Asus' ZenWiFi mesh routers were our favourite. The two-node systems used a backhaul channel that delivered on the promise of 'performance at distance' in a way that regular Wi-Fi mesh systems had failed to achieve. Now, here's the gaming version of the ZenWiFi. If it performs as good as it looks, we're in for a treat.

The GT6 nodes embrace ROG's latest 'Matrix' design ethos in the form of an Asus-Aura-compatible, zoned-RGB, backlit ROG logo. Even if you don't like the nodes' other 'gamer' flourishes, which includes calls to action like, "Join the Republic" and "For those who dare," the potentially mesmerising lights will still likely leave you loving the looks.

Set-up is simple and involves scanning a QR code on the base, downloading the Asus Router app and setting up network names and passwords. The app has been impressing us greatly over the past year as it looks great, is intuitive to use, displays core information clearly and is packed with features.

The primary screen shows you what's on your network, its status and asks what type of application traffic you'd like to prioritise. You can also adjust the RGB patterns on each node (and manually turn them off... every night). An Insight

■ Wi-Fi 6 10,000Mbps | Connectivity: 3 x Gigabit Ethernet, 1 x 2.5Gbps WAN, USB-A 3.2 Gen 1 | Features: 1.7GHz tri-Core CPU, Trend Micro Security and family controls, extensive QoS optimisation, Alexa and Google Assistant compatible.

tab provides useful suggestions regarding performance and security. The Family tab offers excellent parental controls which bind people and devices to rules about access time and content. The final tab offers access to many advanced settings which, along with the usual router features, include Asus' Trend Micro-based AiProtection for fending-off intrusions and securing smart home devices on your network; Instant Guard to use a secure VPN on public networks plus Google Assistant and Alexa integration.

In terms of physical features, it has three Gigabit LAN ports, a 2.5Gbps WAN port and a fast, USB-A 3.2 Gen 1 port. The latter works best with the Desktop-browser-accessed USB apps and can be used as a file, print, media or backup server, 4G WLAN connection or BitTorrent client. Other Desktop-browser-friendly settings include unique gaming features like Game Radar (which shows pings to different games' servers) and all manner of other lag-related monitoring and optimisation tools.

As for performance, it downloaded

larges files from our NAS to our Dell XPS laptop at a screaming 910Mbps up close, 864Mbps three rooms away (in the front of our Sydney weatherboard cottage) next to the second node and finally 94Mbps, 25m away at the end of the garden. Special 'Smart Antennae' directional technology helps the dedicated node connection stay incredibly strong, but, as the garden result shows, performance falls away when absent.

Still, it's the fastest kit we've ever tested, it's laden with features and the nodes look amazing. The issue is the \$1,299 price tag. Synology's rivals are better, cheaper though much uglier. Meanwhile, Asus' own, older, ROG rivals (with identical gaming features) have collapsed in price, meaning buying two and linking them offers potentially significant savings. But, as a single, out of the box, dual node system, this is the best.

Premium performance, fabulous features and awesome aesthetics are hampered by a high price.  
**Nick Ross**

★★★★★



GRAPHICS CARD

# MSI RTX 4070 Gaming X Trio

Cool, quiet and actually pretty decent value.

■ \$1,169 | msi.com

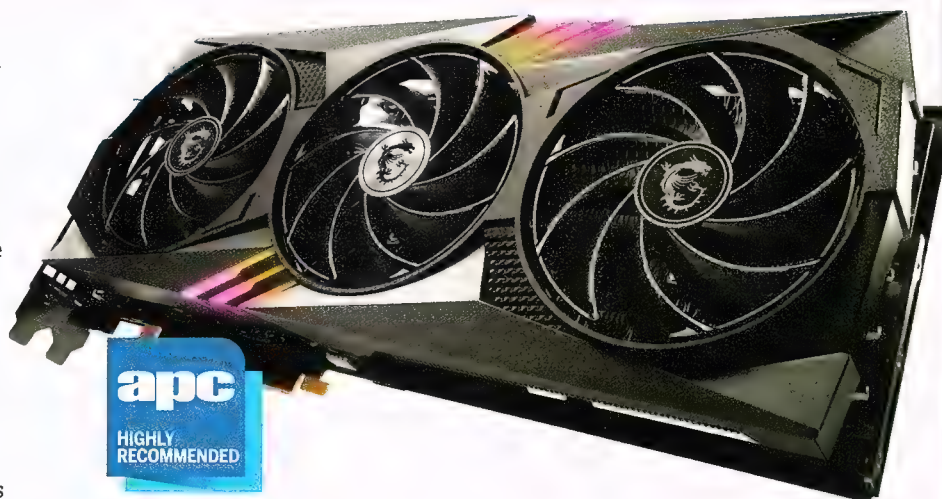
Isn't it great to see capable graphics cards available at prices that won't make you keel over in shock? Ok, that's not exactly true, but given the bonkers GPU market of a couple of years back, GeForce RTX 4070s starting from \$999 are a dead set bargain. While you can't call a \$1,000+ GPU an affordable one, it's good to see the latest generation cards hitting price points that are more attractive than we've seen in a long time.

Here for review I have MSI's RTX 4070 flavour, specifically the GeForce RTX 4070 Gaming X Trio. The Gaming X series often impresses me, usually delivering a near perfect balance of temperatures and low noise levels that allow the card to hold high boost clocks without too much compromise. But given the RTX 4070 is a highly efficient GPU, is the big triple fan Gaming X Trio cooler really necessary?

The MSI RTX 4070 Gaming X Trio, like all RTX 4070s, is based on the 4nm AD104 GPU, albeit a heavily cut down version of the one found in the RTX 4070 Ti. It comes with 5,888 CUDA cores, 46 RT cores, and 184 Tensor cores. This compares to the 7,680 CUDA cores, 60 RT cores and 240 Tensor cores of the 4070 Ti.

Thankfully, Nvidia didn't cut down the memory subsystem. Both the 4070 and the 4070 Ti come with the same 12GB of 21Gbps memory over a 192-bit memory bus. However, no matter how much GDDR memory speeds improve, the idea of a card with a 192-bit bus costing over \$1,000 irritates me.

The MSI Gaming X Trio comes with a factory overclock at 2,610MHz, a decent 135MHz increase over the 2475MHz reference speed. The TDP of the card is



"While you can't call a \$1,000+ GPU an affordable one, it's good to see the latest generation cards hitting price points that are more attractive than we've seen in a long time."

a very respectable 215W, a modest 15W increase over the TDP of the 4070 Founders Edition and over 100W less than the RTX 3080. The MSI Gaming X Trio includes the now common 16-pin 12VHPWR power connector. MSI ships a 2x 8-pin power adapter for use with older power supplies. MSI recommends a minimum 650W power supply.

Like most RTX 4070s, and indeed most RTX 40 cards, the MSI includes three DP 1.4 ports plus one HDMI 2.1 port. DP 2.0 would be nice, but given the 4070 isn't really a high FPS 4K card, let alone an 8K capable one, its omission is not that important.

The low operating temperature of the card allows it to maintain high boost clocks essentially indefinitely. The MSI Gaming X Trio has a rated boost clock of 2,610MHz, but my sample was able to sit at an average of 2,785MHz and with a peak temperature of just 57 degrees, the card has a lot of temperature overhead. In fact the MSI's fans were spinning at just 30 percent!

The RTX 4070 is able to run games at anywhere from 1080p up to 4K, though obviously the most demanding modern titles will require you to dial back the settings a little or enable DLSS to maintain smooth frame rates.

Nvidia's fourth RTX 40 series card is a welcome one. While the RTX 4070 Ti is also a good card, it's expensive. The RTX 4070 is slower for sure, but starting at around \$1,200, it's a good deal cheaper and is a very good 1440p card. It's power efficient, cool, quiet and packs in the latest tech common to all RTX 40 series cards.

If you don't want to spend the big bucks on a RTX 4080 or 7900 XTX, the MSI RTX 4070 will give you solid performance with excellent power efficiency and do it in silence.

Chris Szewczyk

★★★★☆

|                                                                    | AMD Radeon RX 6600 XT | Nvidia GeForce RTX 3060 | Intel Arc A750 |
|--------------------------------------------------------------------|-----------------------|-------------------------|----------------|
| Total War: Warhammer III<br>1920x1080 Ultra Preset - Avg           | 65                    | 70                      | 65             |
| F1 2021 - 1920x1080 Ultra<br>High Preset - Avg                     | 98                    | 94                      | 90             |
| Far Cry 6 - 1920x1080 Ultra Preset - Avg                           | 118                   | 100                     | 92             |
| Metro: Exodus Enhanced Edition -<br>1920x1080 Extreme Preset - Avg | 33.3                  | 35.7                    | 38.1           |
| Power - Full system power (w)                                      | 234                   | 254                     | 301            |
| Temperatures (C) - Peak load                                       | 73                    | 64                      | 72             |
| 3DMark                                                             | 4,705                 | 4,440                   | 6,376          |

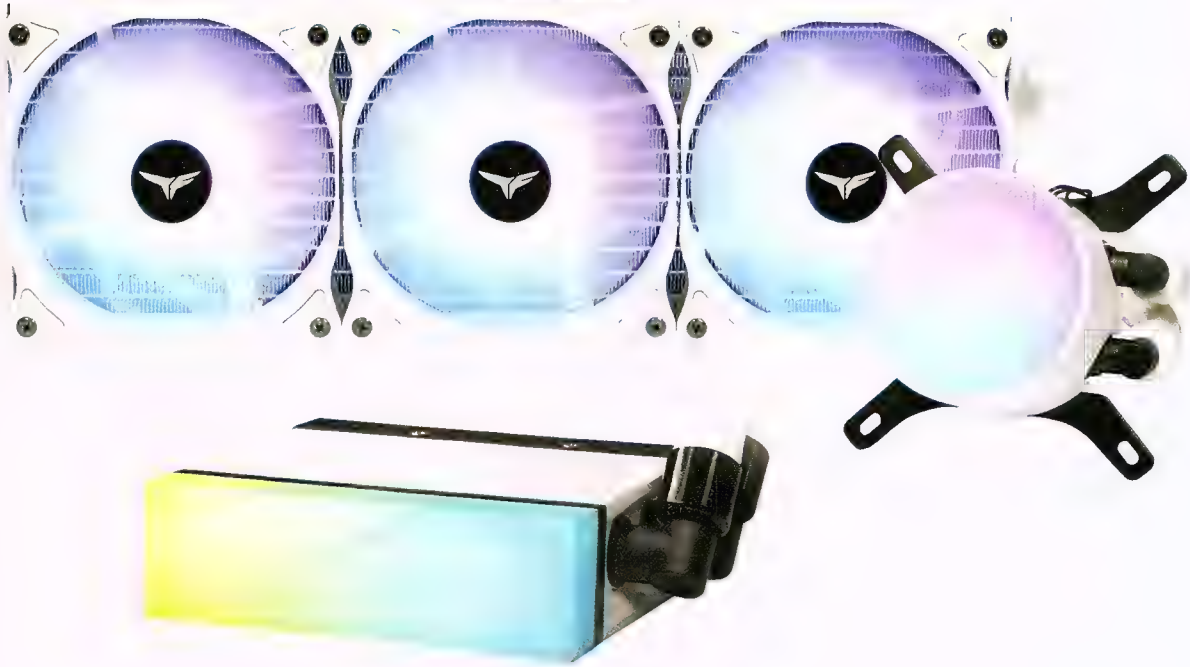


## COOLING

# Teamgroup Siren Duo360 AIO cooler

*AIO cooling for your CPU and SSD.*

■ \$599 | teamgroupinc.com



All in one cooling tends to get a bit samey. One model might have an LCD screen or an RGB variation, but at the end of the day they're fundamentally similar. Not so the Teamgroup Siren Duo360. Yes, it's a 360mm CPU cooler, but it's also an SSD cooler. That's right! It includes a second waterblock to cool an M.2 SSD.

PCIe 5.0 SSDs in particular can get very hot, particularly if they are uncooled or sitting adjacent to a hot running graphics card. Motherboard manufacturers are aware of this. Many of the latest motherboards come with chunky heatsinks. But while it's important to keep an SSD cool, it's important to dissipate that heat effectively, and that's what elevates the Duo360 to a new level.

The Teamgroup Siren Duo360 is a stylish white coloured AIO with hydraulic bearing ARGB fans. It supports almost every socket released in the last decade, with the exception of AMD's Threadripper sockets.

The CPU block has ARGB lighting while the baseplate is made of copper. Our example was very finely machined to a near mirror like finish. Note that the Duo360 doesn't come with an LCD display which you'd expect on a high end AIO.

The really interesting part is the M.2

■ Supports M.2 2280 SSDs; AMD AM5, AM4, AM3(+), AM2(+), FM2, FM1, Intel LGA 1700, 1200, 115x, 2066, 2011(-3) & 1366 compatible; 3x hydraulic bearing fans; up to 4000 RPM pump; max 39.5 dB(A) noise level.

2280 SSD block. It too features a copper baseplate. It comes with a magnetically attached ARGB section that you can theoretically place elsewhere in your case if you wanted to. The block has a retention mechanism with thermal pads. You then install the entire block (with the installed SSD) into your motherboard's M.2 slot. It was easy with my test motherboard.

When it comes to CPU cooling performance, the Siren Duo360 performed well, essentially matching some of the other 360mm AIO coolers I have tested. I used a Ryzen 7 5800X for testing in a 22-degree environment and recorded a peak load temperature of 72 degrees in a closed case.

For SSD testing, Teamgroup provided a Z540 Cardea 2TB PCIe 5.0 drive. I was asked not to provide specific performance results of the drive as its firmware will be revised prior to the retail release. I can say that the drive ran no less than 25 degrees cooler with the AIO installed compared to the stock motherboard heatsink. Incredible! I didn't see any significant temperature related throttling without the AIO but I

did note a drop off towards the end of a 50GB internal file copy when the drive temperature climbed to 70 degrees.

The Teamgroup Siren Duo360 is an innovative cooler that will certainly benefit users running hot PCIe 5.0 SSDs, but only under intensive workloads. It's generally quiet, though it will get loud if pushed hard. It's well built and looks great.

However, it's very expensive. At \$599, it's set to be the most expensive AIO on the market. So, while it's an innovative and functional cooler, at almost \$600, it's one for ultra-enthusiasts only. Still, we like it. We could be looking at a new class of liquid cooling and one that could generate some buzz as the faster PCIe 5.0 drives arrive on the market.

The Siren Duo360 is an excellent and innovative product albeit a very expensive one. It's one for ultra-enthusiasts only.

Chris Szewczyk

★★★★☆



MEMORY

# Crucial DDR5-5600 2x16GB C45

An unremarkable kit perfect for unremarkable PCs.

■ \$209 | [crucial.com](https://crucial.com)

DDR5 memory has come a long way since its inglorious launch. Component shortages meant DDR5 was scarce and resulting high pricing hampered adoption. In the 18 months or so since then, kits have drastically dropped in price, speeds have gone up, relative latencies have come down and the competition is fiercer than ever.

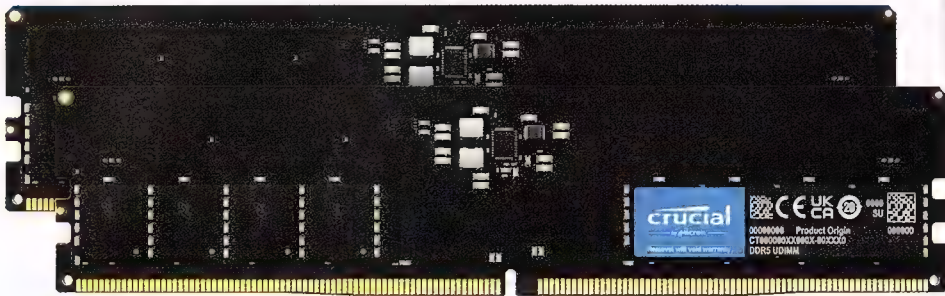
Ideally, I wish I was here talking about one of Crucial's historically well regarded Ballistix kits, but sadly, the Ballistix brand is no more. Instead I have a 2x16GB set of Crucial DDR5-5600. It's made up of a pair of basic bland green PCB single sided sticks. That's it. It's the very definition of a generic kit. You won't find fancy heatspreaders, RGB lighting or loads of hidden overclocking potential.

Firstly, a look at the specs of the kit. At 5600MHz, the kit conforms to the latest JEDEC compliant speed, and is officially certified to support Intel's 13th Gen Core series processors. That might not mean a lot to enthusiast PC users, but for system builders looking for the low risk and wide compatibility, it's the kind of kit that's perfect for the job.

Other key specs include unimpressive timings of 46-45-45-135, but the low operating voltage of just 1.1V is well under what typical enthusiast tier kits typically run at. This Crucial kit is unexciting - In terms of looks and on-paper spec.

In typical tasks the Crucial is a step above the base 4800MHz kits, though the differences are usually visible in synthetic tests only. Handbrake is an interesting one that clearly favours faster memory.

My advice remains the same in



"As enthusiast gamers, the Crucial kit is one to skip. You'll find better value elsewhere, with faster speeds, tighter timings and a more appealing aesthetic."

2023 as it did in 2022 and 2021. Spending big bucks on DDR5 only makes sense if you've got a high spec system to take advantage of it. Think a Core i9 13900K and RTX 4080 or 7900 XTX or above. If you don't have that kind of spec, spend your money on a CPU or GPU upgrade rather than 6400MHz+ memory. You'll see bigger and more tangible performance improvements that way.

If you have a Dell or HP or any kind of OEM PC that came with a sluggish (and expensive) first gen 2x8GB 4800MHz kit, you can rest assured knowing that this kind of system will happily accept this Crucial kit with ease. It won't stress a motherboard and its easy 1.1V compatibility and official 13th Gen support means it's truly plug and play. That's its strength.

But as enthusiast gamers, the Crucial kit is one to skip. You'll find

better value elsewhere, with faster speeds, tighter timings and a more appealing aesthetic. It's true that heatspreaders are more about looks than cooling, but they're nicer to look at than a bland green PCB. At least the sticks won't interfere with the vast majority of CPU coolers.

Crucial needs to drop the price of the 5600MHz kit if it is to appeal to DIY PC builders. The market needs a strong and viable Micron to avoid an over-concentration of supply in the hands of Hynix or Samsung. I would love to see Micron competing head to head with an enthusiast tier IC. Sadly, this Crucial kit and its Micron chips aren't enough.

If you need a reliable, no fuss upgrade, a kit like the Crucial DDR5-5600 has a place in the market.

Chris Szewczyk

★★★★☆

|                 |                                 | Crucial DDR5-5600<br>2x16GB C45 | G.Skill Trident Z5<br>DDR5-6400 C32 | Kingston Fury Beast<br>DDR5-6000 C36 | G.Skill Trident Z5<br>DDR5-5600 C28 | Corsair Vengeance<br>DDR5-4800 C40 |
|-----------------|---------------------------------|---------------------------------|-------------------------------------|--------------------------------------|-------------------------------------|------------------------------------|
| Cinebench R23   | Multi-thread index score        | 40,111                          | 40,247                              | 40,186                               | 40,338                              | 40,278                             |
|                 | Single-thread index score       | 2,281                           | 2,274                               | 2,277                                | 2,268                               | 2,282                              |
| Handbrake 1.5.1 | FPS                             | 92.68                           | 93.12                               | 93.33                                | 93.96                               | 89.11                              |
| 7Zip 22.01      | Billion instructions per second | 193.27                          | 206.72                              | 203.92                               | 202.95                              | 188.12                             |
| AIDA64          | Read                            | 87,047                          | 100,826                             | 94,704                               | 88,704                              | 76,264                             |
|                 | Write                           | 77,555                          | 87,793                              | 83,957                               | 79,628                              | 68,889                             |



ALL IN ONE COOLING

## Asus ROG Ryuo III 360

Superior cooling with a very unique display aesthetic.

■ \$419 | rog.asus.com



The third generation of Asus's Ryuo AIO CPU cooler is the top tier in the company's cooling range, as the price might have made apparent. It's a standard configuration, with three 120mm RGB fans and a display. Unlike almost every other AIO you can buy today, though, the display uses an LED matrix instead of the more common LCD or OLED, or just basic RGB.

It's impressive from the get-go. The packaging is excellent, with the radiator was very well protected by stiff plastic. Out of the box, our test unit had not a single deformation on any radiator fin. The braided tubes appear to be high quality, and their 400mm length allows installation just about anywhere you like in your case without adding any stress on them through stretching or bending to make it reach.

The pump is an Asetek unit, an eight-gen type boasting an extra-large cold plate that can easily sit astride today's ever-larger CPUs. This particular Asetek unit is well regarded and is considered one of the best in the industry right now.

Once you've got it up and running, you'll either need to let BIOS or a third-party app handle the fan speeds, or, install Armoury Crate to access the

custom fan profiles, as well as the fan RGB and display LED settings. We're not especially keen on Armoury Crate, it just tries to do too much and reminds you of its presence constantly, but there's no way around it if you want to customise the looks and access Asus cooling profiles.

We attached it to an Intel 13900K for testing. Really, this is exactly the kind of CPU the Ryuo III is designed for – being big, and very, very hot. The Ryuo III is overkill for anything less than a recent-gen i9, in terms of performance at least. The unique LED display may sway you if you have lesser performance needs, but especially like the look of the display.

We saw temps hit 87-90C running Cinebench R23 using Auto fan settings, which we recommend. More aggressive fan profiles introduce noise that's not welcome if you're not wearing headphones. It's not a painful sound, just a dull roar. After experimenting on higher fan speeds we felt Auto was the best choice for a good balance for actual gaming use.

The display is certainly unusual.

**"The Ryuo III is overkill for anything less than a recent-gen i9, in terms of performance at least."**

Taking a design cue, we expect, from some recent Asus ROG laptops which use an LED matrix on the back, the Ryuo III's large LED dots offer an unusual aesthetic. The 'resolution' is too low to effectively display GIFs, but that's not the design intention here. There are many pre-set designs you can use, create your own, or display system info.

The problem is the price. At around \$420 right now it's a huge jump over something like the Cooler Master Masterliquid 360, which offers capable performance for just \$160. It's certainly a very premium price, but you do get outstanding build and material quality, the best Asetek pump right now, and the very unusual display, along with a generous six year warranty. For a OTT 13900 build where it's budget be damned, it's a fine choice.

The Ryuo III is Asus's new cooling king, you'll see excellent performance and the display is unique, though the price is very high.

**Ben Mansill**

★★★★☆



POWER SUPPLY

# Corsair RM 1200x Shift 80 Plus

*The cables plug into the side!*

■ \$389 | [www.corsair.com](http://www.corsair.com)



Innovation is an unfamiliar friend in the world of power supplies. Right now we're enjoying a rare phase of fresh features thanks to the new PCIe 5.0 standard, and that's the first bit of 'excitement' in years. PCIe 5.0 primarily brings the new the 12VHPWR connector the 40 series Nvidia cards demand, and it's able to deliver a stable 600W, compared to the older 8-pin connectors, each of which could handle up to 150W.

The Corsair RM 1200x Shift 80 Plus is PCIe 5.0 & ATX 3.0 compatible, and it's a top of the line PSU in all other respects. This 1300W box of power is rated at 80+ Gold, which is essential when you're dealing with power output so high – you want all the efficiency you can get to keep your rig relatively quiet, lower electricity costs, and hopefully give the product a longer lifespan. This 1200W model is only available with a Gold rating. Perhaps future higher-wattage models will sport Platinum certification, and ordinarily we'd scoff at the need for such high power

output, but Nvidia is turning up the gas ever increasingly, as is Intel, so this could be the way of the future. AMD CPUs and GPUs demand far less power, so this really is a PSU for Nvidia and Intel builds.

In operation the RM 1200x Shift 80 Plus is extremely quiet, despite its mammoth output, the cooling does a great job and it only barely intrudes.

**"The advantage here is quite simply that building your PC is far easier because you don't need to plug in all your cables before you install the PSU in your case."**

The party piece, though is the side mounting for the cables. This is a big deal, and as obvious as it seems, it's the first time any of us can recall such a design. The advantage here is quite simply that building your PC is far easier because you don't need to plug in all your cables

before you install the PSU in your case, and then deal with an hour or two of manhandling them out of the way as you complete your build. They go in right at the end of the build because the connectors face the side and that can be done last. It's a beautiful experience for anyone that's endured this particular PC-building misery.

The second advantage is that it's potentially tidier, as you won't have a tangle of power cables filling up the bottom section of your case. Yes, that area may be shrouded, but there's always mess and the Corsair RM 1200x Shift 80 Plus removes them from sight completely.

But there's a big caveat – your case must have enough space in the section behind the motherboard to accommodate the cables. And that's going to be in the area where all your other cables are. So, you need somewhere in the region of 4-5cm of clearance in the back or it'll be a crush, which can potentially damage connectors, or even make your case bulge outwards.

This is a PSU for those that tick those boxes. But it's also one for people that upgrade components frequently. There's no pain greater than trying to get a cable plugged into a hole you can't really see that's already crammed with cables. So it's a very niche PSU, but also a very welcome one to many.

The unique side-orientation of the connectors is a gift to builders, but make sure your case has enough room.

**Ben Mansill**

★★★★☆



POWER SUPPLY

## MSI MEG Ai300P PCIE5 PSU

*The first ATX 3.0 PSU offers premium power.*

■ \$609 | [www.msi.com](http://www.msi.com)



MSI has a solid collection of power supplies for all sorts of PC builds. Whether you require something affordable that doesn't have the best efficiency rating or power output, or you have the available budget to go all-out for a PSU that can handle some serious overclocking, MSI likely has a unit that suits your needs.

MSI tells us that this is the first ATX 3.0 Ready PSU on the market – and although that may be true by some small margin, it does not really say anything about the product itself. The specifications of the MEG Ai1300P PSU that we are reviewing today are extremely impressive, as expected from the flagship product of a premium brand.

The MEG Ai1300P is a fully modular power supply that adheres to the ATX 3.0 standard. As well as the ATX12V v3.0 and EPS 2.92 certification, MSI's MEG PSU also has a sticker for 80 Plus Platinum, meaning this unit should be capable of achieving at least 90 percent power efficiency when converting AC to DC at various load levels.

What that tells us is that the MSI MEG Ai1300P has everything you need for a powerful PC build. We don't have

the means to measure ripple and other variations in power conversion, but we are able to monitor efficiency and how the power supply performs through use with a PC.

A single 130mm blower is at hand to cool the high-quality Japanese internals. For cables, there's the usual selection of connections you'd find with many ATX power supplies, including a bunch of PCIe. MSI also includes a 12VHPWR connector with a throughput of 600W for the latest graphics cards.

Running the Ryzen 9 7950X and RTX 4090 we tested it with requires considerable headroom in power output. The MEG Ai1300P can supply up to 1300W in total, with 600W through the 12VHPWR connection. It's more than enough, even for overclocking. You won't encounter any issues running the best hardware with this PSU.

At lower loads, this PSU may not be as efficient as other power supplies, but when you're pushing it hard, it earns that 80 Plus Platinum rating. The fan kicks in at around 50-60 percent and gets louder as you approach full load. As is the case with other high-end power supplies, MSI

includes various safety protocols.

Power supplies have largely been the same since the ATX 2.0 standard was introduced in 2003. We've seen iterations over the years but moving up to 3.0 is the first leap in almost two decades. It's fitting as we're using far more power with recently released processors and graphics cards. The MSI MEG Ai1300P is about as good as you can get, although the price is imposing.

Having 1300W of available power output is a massive plus for those looking to use 13th Gen Intel or AMD Ryzen 7000 processors with an Nvidia RTX 40 series GPU. Throw in the power required by the motherboard, as well as everything else connected to the PSU, and it all quickly adds up. Being 80 Plus Platinum certified is but the icing on the sweet cake.

MSI has caused a mighty splash with the company's first ATX 3.0 power supply. It's mighty good and designed to handle even more powerful enthusiast PC builds.

**Rich Edmonds & Ben Mansill**

★★★★★



## KEYBOARD

# Asus ROG Azoth

*A classy, quality keyboard with many extras.*

■ \$399 | rog.asus.com



The Asus ROG Azoth could make you reconsider some of your biases surrounding keyboards. It certainly did that for me, as before I used the Asus ROG Azoth, I dismissed compact gaming keyboards for feeling too cramped and not offering enough additional features I've come to love about the full-size keyboards I usually use to type and play games on.

As a 75% keyboard, it keeps its size down by jettisoning certain keys. You don't get the numpad, and the keys that remain are cleverly moved to minimise space. Most importantly of all (for me at least), the four arrow keys are maintained. I use these a lot not just in games, but when typing, as it's a quick way to jump around a document.

The overall design and build quality of the Asus ROG Azoth is exceptional. It's a weighty keyboard, but it feels incredibly robust due to its aluminium frame. The keycaps are PBT doubleshot and feel great to type on. Again, they feel robust, and a light texture keeps your fingers from slipping. The keys are backlit by per-key RGB lighting that can be configured in the Armoury Crate software and offer a wide range of customisation.

The customization doesn't end there,

■ Bluetooth 5.1/RF wireless keyboard; 10m range; RGB per-key lighting; USB-C; supports macOS 10.11 or later, Windows 11; 326 x 136 x 40mm (WDH); 1.2kg; 2yr warranty.

as you can easily remove the keycaps and replace them. You can swap out the switches as well. The Asus ROG Azoth is a compact keyboard that's clearly aimed at keyboard enthusiasts that like to fine-tune their keyboard, as well as beginners looking to get into keyboard customization. It even comes with a switch opener, keycap puller, switch puller, lube station and a brush. The keys come pre-lubed, but there's also a bottle of Krytox GPL-205-GDO lubricant included that lets you add more depending on your preference.

By default, the Asus ROG Azoth comes with custom ROG NX switches, and these make the keyboard feel satisfying to type on, with a responsive and pleasant feel when pushed. They're not too loud, so you won't annoy people while you hammer away on it, but nor do the switches feel too soft. They are a great starting point for people getting into mechanical keyboards, and the great thing is, if you're not keen on them, it's incredibly easy to swap the switches out for your preference. The included tools make this a cinch, and the solid build quality means you can happily rip out

the keys and switches without worrying about breaking anything.

The other noticeable additions to the Asus ROG Azoth that make it stand out amongst smaller keyboards are the inclusion of a small black and white OLED display and a three way control knob. By default, you can use the knob to raise or lower volume, but by pressing the button on its face, you can switch between modes. Meanwhile, the OLED display shows the battery life and connection, as well as an animation.

There's no doubt that the Asus ROG Azoth is one of the best mechanical keyboards you can buy, but it does come at a price – and that may be the main stumbling block for some people. At \$399, this is a big investment for a keyboard. There's a lot to love about this keyboard, but there's no denying it's expensive.

*A compact wireless gaming keyboard with excellent build quality, replaceable keys and a responsive typing experience.*

**Matt Hanson**

★★★★★



MOUSE

# MSI Clutch GM51 Lightweight Wireless

*An excellent all-rounder, though not especially "light".*

■ \$159 | msi.com

MSI's new Clutch GM51 Lightweight Wireless gaming mouse weighs 85g, which is kind of heavy by lightweight mouse standards. It features an ergonomic design, grippy sides with RGB-infused "diamond lightgrips," and it sports an excellent PAW-3395 sensor that puts the mouse in league with the best gaming mice on the market today.

The mouse also boasts an impressive 140-hour battery life (with the lighting turned off, of course), and it includes a wireless charging dock (which doubles as a USB extender). A wired version is also available for \$129.

The surface is allegedly anti-smudge, but I started seeing oil from my fingertips after just an hour or two of use. Its sides are what MSI calls "diamond lightgrips," which are lightly-textured, soft, grippy-feeling thermoplastic elastomer. While its predecessor had an ambidextrous design, the GM51 is ergonomically contoured for right-handed users.

The GM51 has five programmable buttons – left click, right click, scroll wheel click, and two thumb buttons on the left side. The button setup isn't particularly exciting, but I found no issues with the buttons during my testing. The scroll wheel is notched, tactile, and relatively quiet; it won't please those looking for ultra-smooth hyperscrolling, but it's well-balanced for a notched wheel – not too tight, and tactile without being clunky.

The Clutch GM51 Lightweight Wireless comes with a 2m braided USB-C to USB-A cable, a wireless charging dock, and a 2.4GHz wireless USB-A dongle. The dongle can be stored in the front of the

mouse (the USB-C port is tucked inside a USB-A-shaped channel) for travel, which is a nice touch.

It's nice to see a wireless charging dock. The dock is pretty unassuming: small and black, with MSI's dragon logo printed on the back in dark grey. It comes with the mouse's 2.4GHz wireless dongle plugged in (it doubles as a wireless extender), and it's easy to use – the mouse clicks in easily and charges quickly. The dock also features cable routing on the bottom, as well as a ring of micro-suction tape for sticking it to your desk.

It sports a PixArt PAW-3395 sensor, which has a maximum sensitivity of

26,000 DPI, a maximum speed of 650 IPS, and can handle up to 50 G's of acceleration. It has the same Omron mechanical switches as its predecessor, which are rated for up to 60 million clicks. Clicking the left and right mouse buttons felt consistently satisfying – light enough for speed, but not so light as to trigger misclicks.

In use it's responsive and has reliable clicks, but it didn't wow me with its performance or impress me with its feel. The side grips were grippy enough that the mouse didn't slip from my fingers when I picked it up, but they felt like they might get gummy with wear, and the mouse's otherwise smooth surface started showing fingerprint smudges in the first hour or two of use. It's still a solid gaming mouse, especially for less competitive gaming.

The Clutch GM51 Lightweight Wireless is a decent gaming mouse, it's just not really lightweight enough to compete with the slew of lightweight gaming mice on the market. If you're looking for a lightweight mouse, the Razer DeathAdder V3 Pro remains my ride or die – but for a budget-friendly pick, the Corsair Katar Elite Wireless is a good option.

The Clutch GM51 Lightweight Wireless mouse isn't very lightweight, but it's got great battery life.

Sarah Jacobsson Purewal

★★★★☆





CASE

# MSI MEG Prospect 700R

A luxuriously premium case with excess everywhere that matters.

■ \$609 | msi.com



If you want a properly roomy case, and/or just want something imposing and magnificent-looking, MSI's new Prospect 700R is the business. It's MSI's most premium case, and while you may balk at the cost, when you consider what you get the price is basically right.

The type of person that will splash out on a case like this is very likely to also own a big new graphics card. With 4090s pushing 360mm in length or more, many upgraders will have hit the wall, literally, trying to install one in their old case. The 700R can handle up to 400mm worth of graphics card, so there's plenty of room to spare for a thick front mounted AIO, too. Big E-ATX motherboards are easily accommodated. Nice.

The rest of the internals are also cavernous. It can comfortably hold a trio of 140mm fans, or an AIO, at the top, front, or side, for a total of 10 fans all up. It comes with three good quality RGB 140mm fans pre-mounted in the front, and another in the rear. In our test build we installed a 360mm AIO on the side panel, and added a couple of fans at the top for extraction. This is the sort of case you can fill with relatively slow spinning 140mm fans for a quiet PC but with loads of airflow. Indeed, in our test build we had nine fans installed and the noise was

■ EATX / ATX / M-ATX / ITX; 2x USB 3.2 Gen 1 Type-A, 1x USB 3.2 Gen 2x2 Type-C, 1x HD Audio, 1x Mic; Maximum GPU length: 400mm; Supported fans: Front: Up to 3 x 120 mm / 3 x 140 mm, Top: Up to 3 x 120 mm / 3 x 140 mm, Rear: Up to 1 x 120 mm / 1x 140 mm, Side: Up to 3 x 120 mm; Dimensions: 585x 257 x 537 mm.

nicely muted – which is in large part thanks to the solid build, thick chunky materials and effective sound insulation.

It's a case for those that enjoy a build, and want to plan it out carefully. The entire PSU shroud along with another shroud for the drive cages are removable, allowing you to complete your cabling effortlessly before putting them back once done. Both doors are hinged and latch magnetically. Generous room behind the motherboard tray as well as deep and wide cable channels let you be artful about your cabling. A vertical graphics card mount is included, though not the cable, but that's standard as not everyone will use it and the cables aren't cheap.

At the front a 4.3-inch IPS touch screen tells the world you have a premium case, and it tells you a wealth of info. Much of the cost is probably represented here, but it's not a gimmick. You can control the lighting and fan speeds here, so no app needed. Yay. There's a temperature diode you can place anywhere you like, and it shows here what it reads. It'll even tell you the time and weather. It looks classy,

is a bit of fun to use and is genuinely useful.

It comes in a big heavy box with extremely high quality packaging and is wrapped in a large soft cover. Unboxing starts the good impressions off well. At 15.95kg it's not light, especially so once you've put everything together, but big is also heavy, and this is one gorgeous chonker.

The MSI MEG Prospect 700R can see you through more than one full system upgrade over the years. It's easy to work with and lets you arrange things how you like rather than be dictated by a case's limitations. Style is always personal, but I think it looks absolutely grand and with a powerful system inside you'll just stare at it and be reminded that you're running a very, very serious PC.

MSI's cases just keep getting better and bolder, and the company's ambitions are clear in this statement of a case that is all about delightful excess.

**Ben Mansill**

★★★★★



# SOFTWARE

APPS FOR ALL YOUR PLATFORMS

Licence GNU GPL, various | [www.suse.com](http://www.suse.com)

## SUSE LINUX 6.3

We test this long-established German company's latest distribution effort.  
Can it hold off the competition?



"SUSE's installer is based on YaST, a long-running setup utility that has finally been updated from text mode to a full graphical installation."

Left: The YaST tool assists with the administration and configuration of your hardware.

As an experienced distributor, German company SUSE has been around for many years and is very popular in European markets. One of the reasons for this is undoubtedly due to the large amount of software found on its CDs. It has also recently converted its distribution to run on the Alpha processor, and it has put money into several of the key areas of Linux development.

SUSE's installer is based on YaST, a long-running setup utility that has finally been updated from text mode to a full graphical installation. Sadly, when we started our installation, it told us our 2GB partition was too small for the minimum installation. Wisely,

though, SUSE has also included the original tried-and-tested YaST, and this worked properly. Installation is reasonably quick, although it isn't very neat – first YaST starts, then exits to restart the system services, then it starts again, then exits and waits for a minute before running some scripts. However, it's a reasonably simple installation and the online help is thorough and useful.

YaST is also the main system configuration tool in SUSE, offering different administrative and setup options, from adding new users to configuring modems. For the most part, it's easy to use and powerful, although occasionally it didn't do exactly as

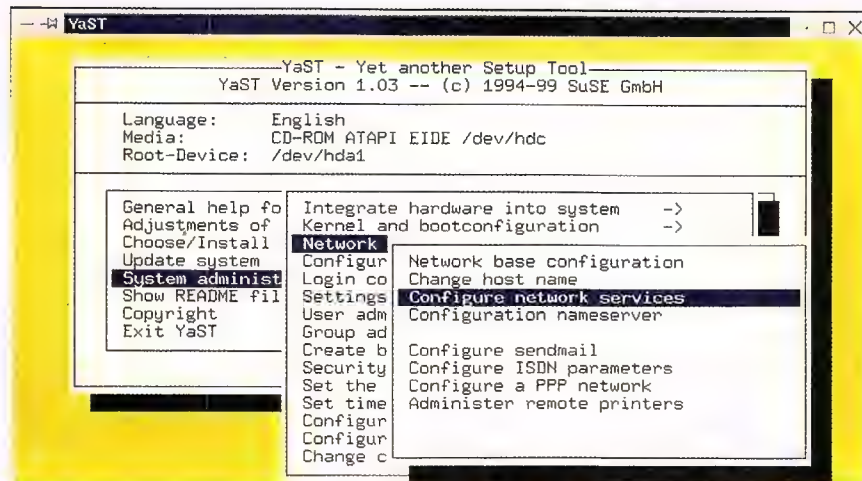
commanded, and if you're editing configuration files by hand, it can have trouble working with them. Like others, SUSE has opted for KDE by default. It is set up fairly well, with icons for the disk drives and easy access to YaST and the help system. One particularly nice feature is the automatic updating of menus – install a new application through YaST and it adds an entry to the KDE menu. This can also work for the FVWM and IceWM menus (among others).

SUSE Linux uses the RPM package format, but we had compatibility troubles installing many off the web. Thankfully, SUSE provides an excellent service on its website for new KDE programs, which are tailor-made to fit the distribution. One cause for concern we noticed was the inclusion of GIMP 1.1.11, which is a development version. The program's docs say that it's an unstable version "intended for developers only", so it seems SUSE is chasing version numbers here. This is a shame, but a good, wide range of software for both desktop and server is included, which makes up for it. In all, SUSE is a generally good distribution with some attractive features. Unfortunately, some of its quirks hold it back slightly.

A decent distribution with some clever features  
and a wide choice of software.

APC

★★★★★



KDE with the SUSE menu, automatically generated from the installed applications.



Windows 7, 8.1, 10 or 11 | [www.snipca.com/45222](http://www.snipca.com/45222)**SSD FRESH 2023***Drive optimiser*

Solid-state drives (SSDs) are much faster than traditional hard drives, but they can suffer performance problems when they're not configured correctly. SSD Fresh offers a simple way to analyse and optimise your drive, and potentially extend its life. This new version has a redesigned interface that makes the program even easier to use, and provides additional data about your SSD.

When you run SSD Fresh, it tells you your SSD's current 'health status' and temperature, and lets you perform an analysis to find out which processes are writing data to the drive. You can also see how much free space is available and your system's level of optimisation.

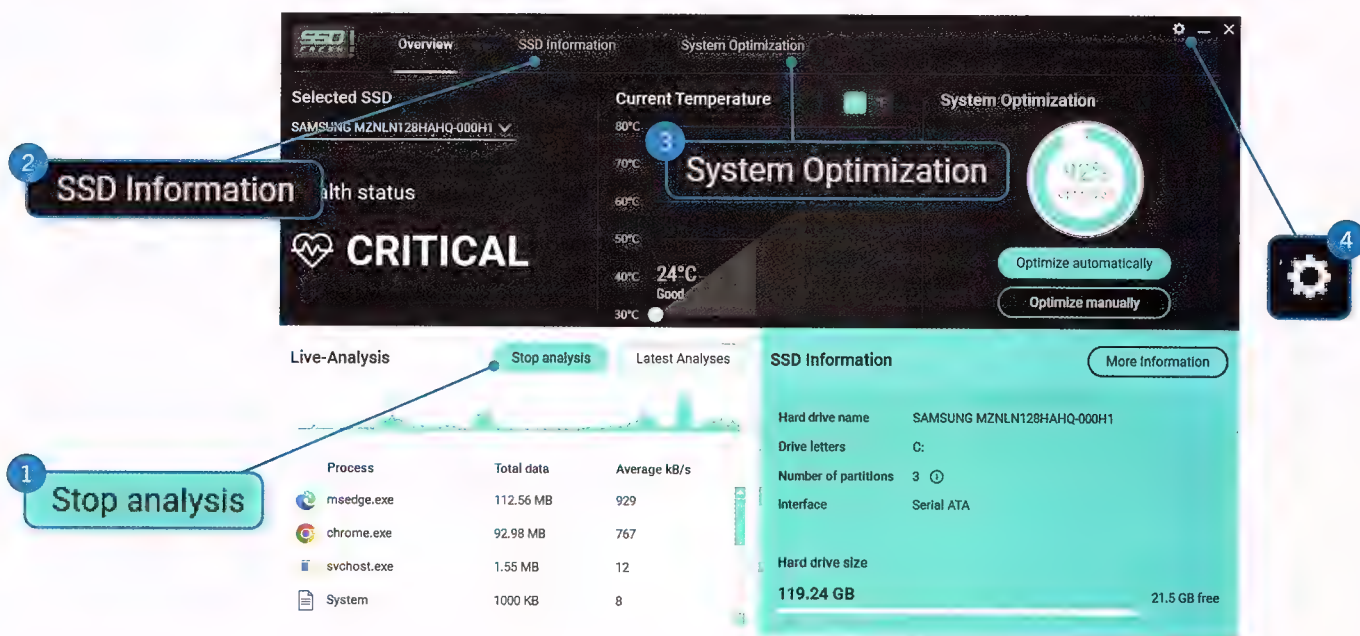
Click the 'Optimise automatically' button and SSD Fresh will apply all its recommended tweaks in one go.

Alternatively, choose 'Optimise manually' to adjust your SSD's settings yourself. These include turning off defragmentation, hibernation and timestamps, and turning on the Windows Trim function, which tells your SSD which blocks of data are no longer in use and can safely be deleted. Once all the recommended settings are applied, your 'system optimisation' percentage should be 92 per cent – to get the full 100, you need to switch off the Indexing option, which speeds up file searches but can reduce your SSD's lifespan. SSD Fresh provides easy-to-understand info about each setting, so you know

what you're changing and why.

Although the program is free to download, you need to provide your email address to unlock SSD Fresh, which is annoying because it allows its developer, Abelsoft, to send you messages about its other products (you can unsubscribe to stop receiving these). It also comes bundled with an offer to install the Opera browser, so make sure you decline this. A paid-for Plus version of the program, which includes extra features such as Background Watcher and Settings Guard, is available for US\$10. Click the Free Download button on the website to get the free edition.

**"SSD Fresh offers a simple way to analyse and optimise your drive, and potentially extend its life."**



**1** SSD Fresh's Live-Analysis feature shows you which processes are currently writing data to your SSD, the total amount of data each one has written, and the average speed in kilobytes per second. Click 'Stop analysis' to save a log of this information.

**2** For a more detailed analysis, click the SSD Information tab. This provides S.M.A.R.T. (Self-Monitoring, Analysis and Reporting Technology) data, including how many hours your SSD has operated for and the total number of read and write operations.

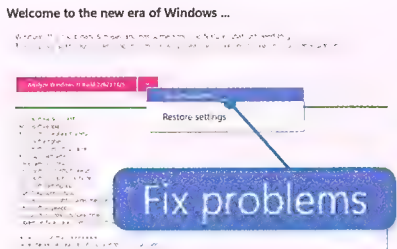
**3** Click the System Optimization tab or 'Optimise manually' to view and adjust your SSD's settings. By applying SSD Fresh's recommendations, you can boost your drive's performance and extend its lifespan by reducing unnecessary 'writes'.

**4** Click the Settings button in the top-right corner to tweak SSD Fresh's own settings. You can stop the program running automatically when Windows starts and decide which notifications you want it to show, such as critical temperature warnings.



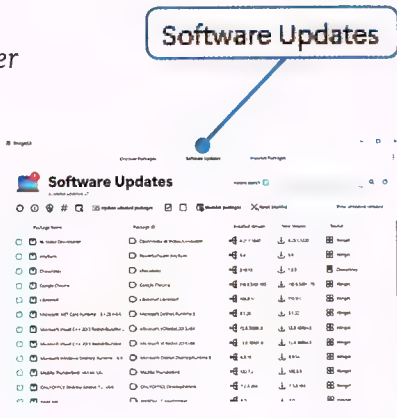
**BLOATYNOSY**  
System tool

BloatyNosy sounds like a character from a children's book, but it's actually a new tool for removing unwanted features from Windows 11, and also works in Windows 10. Click the big pink 'Analyze...' button on the home screen and the program will scan your system for problems, including unsafe privacy settings, bloatware apps and potential annoyances – such as Windows tips. Click the smaller button and choose 'Fix problems' (see screenshot) to deal with these issues – select 'Restore settings' to undo your changes. BloatyNosy also includes options to uninstall and install apps and programs, and to set up Windows 11 for the first time without any of Microsoft's junk. Note that because BloatyNosy is a new tool, you may see security warnings when you download and install it. However, it's safe to use so just click Keep (in Chrome), then 'More info' and 'Run anyway' (in Windows).



**WINGETUI 1.6.1**  
Program uninstaller

WingetUI provides a friendly front-end for the Windows Package Manager, which lets you install, uninstall and update multiple programs in one go. These software packages come directly from Microsoft's repository of thousands of approved programs, so they're free of junk and security threats. The latest update to WingetUI introduces the useful ability to update packages automatically via the program's Software Updates tab (see screenshot). This ensures you always have the latest versions of your favourite software without needing to download them manually. It also now lets you import and export several packages at the same time, which is handy for storing tools on a USB stick, and adds a button that returns you to the top of the lengthy package list, which saves you a lot of scrolling. WingetUI triggers a Microsoft Defender warning, but it's safe to use so click 'More info' then 'Run anyway'.



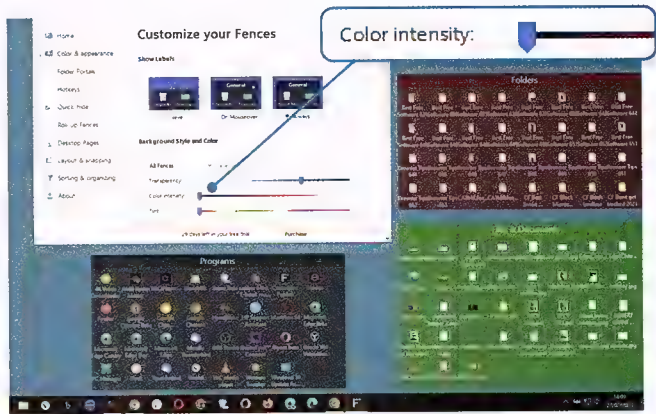
**SHOULD I PAY FOR...?**  
Choose the right version of software

Windows 10 or 11 | \$34.99 Free trial: 30 days  
[www.stardock.com/products/fences](http://www.stardock.com/products/fences)

**STARDOCK FENCES**  
System tool

Other than changing the size of icons and aligning them in a grid, Windows doesn't offer many ways to organise your desktop. This can lead to it becoming cluttered with shortcuts, files and folders. Stardock Fences offers a simple but effective way to clean up your desktop and keep it tidy, so you can quickly find items when you need them. It works by arranging your desktop icons into themed groups called 'fences'. The default options are Programs, Folders and 'Files & Documents', but you can rename these if you want and easily create your own fences by drawing rectangles on your desktop. The program lets you customise your fences to look and work exactly the way you want, including changing their colour (see screenshot), transparency and title font, and rolling them up when not in use to tuck away their icons and free up screen space. We particularly like the 'Quick-hide' option, which lets you double-click your desktop or use a keyboard shortcut to instantly hide and show all the icons, and the ability to take daily snapshots of your layout, so you can restore it if somebody moves things around. A handy feature called Folder Portals displays the contents of folders without you needing to open them, and you can set up rules to automatically place items into specific fences based on their name, type or the time of day they were created.

"Stardock Fences offers a simple but effective way to clean up your desktop and keep it tidy, so you can quickly find items when you need them."



**OUR VERDICT:** Pay for it  
Although Fences isn't as cheap as it used to be (it once cost less than \$10), it's still a good investment if you suffer from a messy desktop and will permanently improve how you use your PC. Its price is a one-off payment rather than an annual subscription, and you can try it for free for a month.





FEATURE

# Mini PC & NUC roundup

Joel Burgess takes a look at what's on offer from today's smallest PCs to see if we really need a giant crypto mining rig as our day-to-day desktop.





"For anyone that's worried that a miniPC just won't be able to offer enough performance to meet their demanding workloads then you only have to look at the Mac Mini M2 Pro"

It's easy to feel attracted to flashy gaming PCs with the latest components, but if we look at things rationally most of us spend our days on web pages and in spreadsheets; so there's very little need for the latest and greatest graphics cards and liquid cooled computers. In fact, the computer we're most likely to use is one that is so compact that it disappears off the desk entirely – offering a clutter free workspace, primed for productivity.

Intel's Next Unit of Computing (NUC) devices have been pushing the envelope of low-powered compact desktop PCs for many years now and, as a result, the collection of mini-PCs on offer today are no bigger than the power supply unit of your average gaming tower. This gives you the freedom to mount them under the desk or on the back of your monitor for an all-in-one experience using your favourite monitor.

#### The big advantages of small

Not that you would necessarily need to entirely hide these unimposing little powerhouses at all, since they actually

often look pretty slick, like a retro game console or a futuristic NAS box. And despite their compact nature the utilitarian shape of today's mini PCs means there's ample space for all the ports and display interface options you could want, which is a lot when you consider these little devices are capable of running multiple 4K displays and a long list of peripherals.

Some devices in this roundup lean into cutting edge interface options like Thunderbolt and DisplayPort, while others utilise the ubiquitous HDMI display, and some even opt for throwback display options like VGA, which is very much a legacy display tech these days (please send angry faxes to (02) 9161 2931).

For anyone that's worried that a miniPC just won't be able to offer enough performance to meet their demanding workloads then you only have to look at the Mac Mini M2 Pro model to see you can get the creative laptop performance equivalent to a top Intel i7 laptop CPU and a discrete Nvidia GeForce RTX 3050 (mobile). For those that need to work on Windows

then there are a number of Intel based offerings with 12-core CPUs and Iris Xe graphics which is enough for demanding workflows and light gaming. The performance on offer really is more than what most people would need with plenty of headroom to future-proof it for years to come.

#### The Chrome OS option

If you're the kind of modern worker that lives in Google's suite of online office applications then Chrome OS is definitely a viable option. While we're big fans of the OS, availability in Australia is still quite limited. We were only able to source one device for this roundup and its components were a little out of date. It might not have been the best value device but it certainly was the most affordable, so it's worth keeping in mind for anyone who's happy to live in Google's ecosystem to get a bit of a discount on their mini PCs.

Today's mini PCs are capable of almost anything, so maybe it's time to ditch the 'bigger-is-better' philosophy and join us in exploring the best micro computers on offer.



## Cube mini PCs

**ASUS MINI PC PN64 B**

*A powerful barebones rig that can do whatever you want it to.*

■ From \$799 | [asus.com](https://www.asus.com)

The PN64 is a barebones mini PC that comes with a 12th generation i5 or i7 Intel CPU. Starting at \$799 for the i5-12500H and \$999 for the i7-12700H models, this is one of the best priced units in the roundup costing \$1,189 or \$1,389 respectively once you add \$80 for 16GB of RAM, \$50 for a 500GB SSD and \$260 for a copy of Windows 11 Pro.

The PN64 offers all the ports you'd want with multiple easily accessible USB options at the front and HDMI, DisplayPort and Ethernet connections at the back. The compact cube shape will take up a smaller footprint on the desk and you won't miss out on any networking opportunities with Wi-Fi 6E connectivity.

It was also one of the top performers and managed to not be noticeably louder, so it's definitely an option to consider for your workspace.

★★★★★

**MSI CUBI 5 12M**

*A low power mini PC for the large scale eco-conscious company.*

■ From \$499 | [msi.com](https://www.msi.com)

MSI's barebone mini-PC the Cubi 5 12M is the other block-shaped compact computer on offer here. It comes in three configurations of Intel's lightweight 12th gen U series processors: the i3-1215U, i5-1235U or the i7-1255U CPU. Even the top i7 processor here is a little disappointing next to the Intel Core i5-12500H on the Asus PN64, being outperformed by between 50 and 84 percent. This is somewhat redeemed by the fact that it also gets an Intel Iris Xe Graphics integrated GPU which offers roughly double the performance of devices with Intel T-series processors. Despite the conservative CPU performance the barebones Cubi 5 12M starts at \$499, with the i5 unit jumping to \$699 and the i7 unit coming in at \$899. This device does draw much less power, but you'd need at least 20 units before this cost difference stops being negligible.

★★★★☆



## Flat mini PCs

**FUJITSU DESKTOP ESPRIMO G6012**

*An Intel vPro PC that should appeal to those looking for a fleet.*

■ ~\$1,690 | [fujitsu.com](https://www.fujitsu.com)

With a street price of around \$1,690, the Desktop Esprimo G6012 is one of the most expensive devices we looked at in the roundup... especially when you consider the components it's using. This mini PC can be configured with a wide range of processors ranging from Intel Celeron chips up to an Intel Core i7-13700T, but the model we looked at was running a Intel Core i5-12400T.

The G6012 had the best performance out of the T and U processors we tested with scores that mean it's well equipped to tackle any office applications and internet browser activity with enough overhead to tackle light creative workloads and applications. The Intel UHD Graphics 720 offers roughly half the performance of the Intel Iris Xe GPUs, but most standard office workflows won't be too affected by this.

★★★★★





## Flat mini PCs continued

### HP PRO MINI 400 G9

*This mini PC has the latest Intel processors, but is it ready to be released?*

■ From \$1,270 | [hp.com/au-en/](http://hp.com/au-en/)

The HP Pro Mini 400 G9 is the only device we tested to have a 13th generation Intel Core i5-13600T processor, but we were surprised to see that it underperformed in all the benchmarks. The device we were given didn't have a finalised consumer BIOS which caused the unit to perform at half the level APC believes it should be capable of. HP's online store pricing for HP Pro Mini 400 G9 with 12th generation Intel processors starts with an i3-12300T CPU, 8GB of RAM and a 256GB SSD for \$1,270. The 13th generation devices are expected to launch around July 2023 with a projected RRP of \$1,396. If that pricing is for the i5 model we tested, and if it performs as well as the chip should then the HP Pro Mini 400 G9 is more of a 4/5.

★★★★☆



### INTEL NUC 12 PRO

*Is Intel's own mini PC still the player to beat?*

■ From \$499 | [intel.com.au](http://intel.com.au)

There's actually a wide variety of NUC 12 Pro PCs on offer; ranging from a Barebone i3-1220P kit for \$499 that requires you to buy your own RAM and storage, to an i7-1260P system with 64GB of RAM and a 2TB SSD for \$1,479. Intel sent us a more mid-range device with an i7-1260P processor, 16GB of RAM and a 500GB SSD which can be picked up for around \$1,059.

This makes it the best value Windows offers here, an impressive feat when you consider it's also one of the top performing mini PCs of the roundup. The i7-1260P processor offered enough performance to ensure you can get through any standard office workload with plenty of headroom to dabble in more demanding creative software and very light gaming applications.

★★★★★



### SHUTTLE DH610

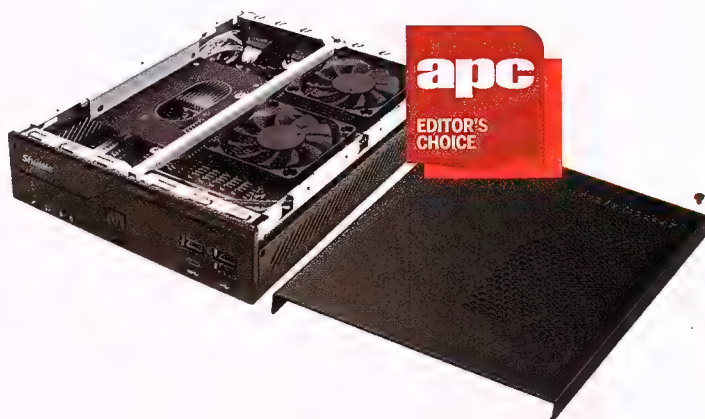
*A more classic mini PC with VGA connectivity.*

■ From \$799 | [au1.shuttle.com](http://au1.shuttle.com)

With some vendors selling the Shuttle DH610 for as little as \$669 it's the lowest cost Windows-based mini PC here, but that doesn't include a CPU, so you'll have to consider that in addition to the usual RAM, SSD and OS costs to get a 'drive away' PC price. An entry level CPU for an LGA 1700 socket costs \$200 at a minimum, which is enough to make this unit more expensive than Asus's PN64 at around \$1,250, even though it's a generation behind in RAM and M.2 PCIe storage specifications.

If you want to connect to older monitors, the DH610 is the only device that offers VGA connectivity, which may appeal to some. It's also got multiple DisplayPort 1.4 sockets, and it also includes an HDMI 2.0 port, which means the Shuttle DH610 can do also well as a media streaming PC.

★★★★★





## Chrome OS & Mac OS

### APPLE MAC MINI

*Is Apple's budget conscious Mac Mini an underpowered gimmick or a silver bullet?*

■ From \$999 | apple.com

The 2023 Mac Mini starts at \$999 for a device with one of the latest M2 Apple silicone processors, 8GB of Unified Memory and 256GB of SSD storage. This makes it the best value device here, when you consider it comes with a full OS and is ready to go out of the box. The device we were sent to cover featured an Apple M2 Pro processor, which starts at \$1,999 and naturally out performed any other device here... but the entry level Apple Mac Mini should offer results that are in-line with the best performing Windows based mini PC here (according to MacBook Air results we have on file). The Mac Mini looks sleek and has the top Wi-Fi, Ethernet and Thunderbolt specs, so there's really no reason we can think of to avoid it.

★★★★★

**ape**

EDITOR'S  
CHOICE

### ASUS CHROMEBOX 4

*A lightweight PC with a lightweight operating system.*

■ \$951 | asus.com

With a street price of \$951, the Asus sneaks in under the Mac Mini to be the most affordable unit in the roundup – once all the necessary component costs have been tallied. That said, it's running a quad-core 10th generation Intel processor with 8GB of RAM, a conservative 128GB SSD and dated Wi-Fi specs, so it really should be the most affordable here.

Those components achieve around half the performance of the lowest Windows based offerings here and the SSD is only capable of 941MB/s read speeds, which isn't as slow as the DH610's SATA speeds, but is a long way from cutting edge.

If you can't bear to use Mac OS then there might be an argument for getting the Chromebox 4, but you're getting much better value from the PN64.

★★★★☆



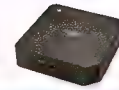
## CONCLUSION

Apple has never been considered an affordable brand, but the entry level Mac Mini is the least expensive non-ChromeOS device you can get your hands on. Despite this very approachable price-point CPU performance in general work tasks is on par with the top Intel based PC, which makes it hard not to be really impressed by Apple's smallest desktop. It's not as good at media encoding as the leading Intel processors, but it makes up for it with graphical performance that is two to three times better than the range of Intel devices here.

If you absolutely can't do anything but a Windows based unit then the Intel NUC 12 Pro is an excellent runner up offering impressive performance in a compact package at a very reasonable price.





|                          |  |  |  |  |  |  |  |  |
|--------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
|                          | Apple Mac Mini M2                                                                 | Intel NUC 12 Pro                                                                  | Asus PN64 B                                                                       | Fujitsu Desktop Esprimo G6012                                                     | Shuttle DH610                                                                     | Asus Chromebox 4                                                                   | MSI Cubi 5                                                                          | HP Pro Mini 400 G9                                                                  |
| Score                    | ★★★★★                                                                             | ★★★★★                                                                             | ★★★★★                                                                             | ★★★★☆                                                                             | ★★★★☆                                                                             | ★★★★☆                                                                              | ★★★★☆                                                                               | ★★★★☆                                                                               |
| Cost                     | \$3,349                                                                           | \$1,059                                                                           | \$1,134                                                                           | \$1,690                                                                           | \$1,285                                                                           | \$951                                                                              | \$1,399                                                                             | \$1,525                                                                             |
| CPU                      | Apple M2 Pro                                                                      | i7-1260P                                                                          | Intel Core i5-12500H                                                              | Intel Core i5-12400T                                                              | Intel Core i5-12400                                                               | Intel Core i5-10210U                                                               | Intel Core i7-1255U                                                                 | Intel Core i5-13600T                                                                |
| Cores/threads            | 12/12                                                                             | 12/16                                                                             | 12/16                                                                             | 6/12                                                                              | 6/12                                                                              | 4/8                                                                                | 10/12                                                                               | 14/20                                                                               |
| Frequency range (GHz)    | 3.5                                                                               | 2.5-4.7                                                                           | 3.1-4.5                                                                           | 1.8-4.2                                                                           | 2.5-4.4                                                                           | 1.6-4.2                                                                            | 2.6-4.7                                                                             | 1.8-4.8                                                                             |
| Memory                   | 32GB                                                                              | 16GB                                                                              | 8GB                                                                               | 8GB                                                                               | 8GB                                                                               | 8GB                                                                                | 16GB                                                                                | 16GB                                                                                |
| GPU                      | M2 Pro (19 Core)                                                                  | Intel Iris Xe Graphics                                                            | Intel UHD Graphics                                                                | Intel UHD Graphics 720                                                            | Intel UHD Graphics 730                                                            | Intel UHD Graphics                                                                 | Intel Iris Xe Graphics                                                              | Intel UHD Graphics                                                                  |
| Storage                  | 1TB                                                                               | 500GB                                                                             | 250GB                                                                             | 512GB                                                                             | 256GB SATA                                                                        | 128GB                                                                              | 512GB                                                                               | 512GB                                                                               |
| OS                       | macOS                                                                             | W11 Home                                                                          | W11 Pro                                                                           | W11 Pro                                                                           | W11 Pro                                                                           | Chrome OS                                                                          | W11 Pro                                                                             | W11 Pro                                                                             |
| Wi-Fi chip               | WiFi 6E                                                                           | Intel Wi-Fi 6E AX211                                                              | Intel Wi-Fi 6E AX210                                                              | None                                                                              | Realtek 8821CE                                                                    | Intel WiFi 6 AX201                                                                 | Intel Wi-Fi 6E AX211                                                                | Intel WiFi 6E AX211                                                                 |
| Ethernet                 | 1 or 10Gb Ethernet                                                                | Intel i225-V Ethernet                                                             | Intel I225E Ethernet Controller                                                   | Intel Alder Lake PCH                                                              | Intel Alder Lake PCH                                                              | Realtek RTL8111H-CG                                                                | Realtek PCIe GbE                                                                    | Intel Alder Lake PCH                                                                |
| Weight                   | 1.28kg                                                                            | 450g                                                                              | 1kg plus                                                                          | 1.275kg                                                                           | 2kg                                                                               | 1kg                                                                                | 1.4kg                                                                               | 1.42kg                                                                              |
| Dimensions (mm)          | 197 x197 x35.8                                                                    | 117 x112 x37                                                                      | 130 x120 x58                                                                      | 146 x165 x36                                                                      | 190 x165 x43                                                                      | 148 x148 x40                                                                       | 124 x124 x53.7                                                                      | 177 x175 x34                                                                        |
| Thickness (cm)           | 3.6cm                                                                             | 3.7cm                                                                             | 5.8cm                                                                             | 3.6cm                                                                             | 4.3cm                                                                             | 4cm                                                                                | 5.4cm                                                                               | 3.4cm                                                                               |
| Geekbench 5              |                                                                                   |                                                                                   |                                                                                   |                                                                                   |                                                                                   |                                                                                    |                                                                                     |                                                                                     |
| Single-core (score)      | 1,954                                                                             | 1,748                                                                             | 1,616                                                                             | 1,571                                                                             | 1,607                                                                             | 1,102                                                                              | 1,589                                                                               | 1,795                                                                               |
| Multi-core (score)       | 14,671                                                                            | 9,387                                                                             | 8,667                                                                             | 5,641                                                                             | 5,373                                                                             | 2,852                                                                              | 5,617                                                                               | 5,709                                                                               |
| OpenCL (score)           | 47,785                                                                            | 17,921                                                                            | 13,281                                                                            | 6,721                                                                             | 6,380                                                                             |                                                                                    | 13,697                                                                              | 8,521                                                                               |
| Crystal DiskMark 8       |                                                                                   |                                                                                   |                                                                                   |                                                                                   |                                                                                   |                                                                                    |                                                                                     |                                                                                     |
| Sequential read (Q32T1)  | 5,792                                                                             | 3,522                                                                             | 3,563                                                                             | 6,774                                                                             | 559                                                                               | 941                                                                                | 3,271                                                                               | 3,618                                                                               |
| Sequential write (Q32T1) | 5,110                                                                             | 2,526                                                                             | 2,376                                                                             | 4,917                                                                             | 509                                                                               | 307                                                                                | 1,692                                                                               | 2,523                                                                               |
| Cinebench R23            |                                                                                   |                                                                                   |                                                                                   |                                                                                   |                                                                                   |                                                                                    |                                                                                     |                                                                                     |
| CPU                      | 14,876                                                                            | 11,562                                                                            | 11,133                                                                            | 9,176                                                                             | 7,961                                                                             | DNT                                                                                | 6,067                                                                               | 4,508                                                                               |
| CPU (Single Core)        | 1,661                                                                             | 1,769                                                                             | 1,693                                                                             | 1,635                                                                             | 1,625                                                                             | DNT                                                                                | 1,584                                                                               | 1,861                                                                               |





FEATURE - PART 6

## (R)evolution of Portable Audio: Play everything, do everything

*It reigns supreme as the portable audio player of choice today, but as Darren Yates writes, the smartphone itself can trace its lineage back to another handheld computer that also wowed crowds.*

**Above:** The new Apple iPhone 14 series – and it still plays music.

**Below:** HP's iPaq HW6910 combined PDA and phone a year before the iPhone hit the market (Image credit: Asim18, CC BY-SA 4.0).



It was the launch of a product the likes of which the world had never seen. Compact and lightweight, its selling point was a computer that fits into your pocket. It amazed all who saw it and launched a whole new class of portable computing. Of course, we're referring to the Tandy Electronics TRS-80 Pocket Computer and the year is 1980. Back then, computers still filled rooms and few of us had one at home. The idea that you could now run a computer on a couple of coin-batteries and slot it into your

pocket was science-fiction becoming science-fact (which is, no doubt, why Tandy Electronics signed up famed author Isaac Asimov to spruik the Pocket Computer in its ads). The launch of the Apple iPhone some 27 years later had an equally transforming effect, not just on digital audio, but portable computing as a whole. Yet while the iPhone had its roots in Tandy's 1980 Pocket Computer, its lineage can be followed closer to home in an equally-ambitious Apple device from the 1980s.

### Cradling the Newton

If there's one product you could argue laid more of the foundations for our modern mobile world than any other, it's the Apple Newton. Work began on the device in 1987, but it would take another six long years before it would be ready for market, bringing with it new technologies.

First, the Newton starred a new Reduced-Instruction-Set-Computing (RISC) processor from a small British PC maker with big ideas called Acorn Computers. The chip was the ARM610, based on the original 'Acorn RISC Machine' CPU (Acorn would become phone-chip design giant

ARM). The idea was that bloated Complex-Instruction-Set-Computing (CISC) chips used in PCs weren't necessary and a lean RISC chip could deliver the performance required with much greater power-efficiency.

But second, the Newton featured a whole-screen monochrome LCD panel with touch capability and arguably its most innovative feature, handwriting recognition. It was modestly successful (both at handwriting recognition and sales), but after burning through more than US\$100million in development, it became one of the first casualties upon Steve Jobs' return to the company in 1997. Nevertheless, despite its overall lack of success, the Newton MessagePad sowed the seeds of technology that drives our everyday world today.

### Palmtop PCs

It's another story for another time, but that 1980 TRS-80 Pocket Computer was actually a rebadged Sharp PC-1211, which itself was an amazing piece of engineering that pressed into service two four-bit CPUs and allowed users to code their own BASIC programs. Hewlett-Packard followed Tandy



**Right:** The Apple Newton MessagePad pioneered the all-screen handheld computer concept (Image credit: Rama, CC-BY-SA-2.0-FR).



Electronics in 1982 with its HP-75, as did Psion in 1984 with the Organiser I. But as portable computing devices of the time, they were fine for small simple programs, but not much else, let alone playing digital audio.

Continued improvements in CPU capabilities during the early-1990s led to a new-generation of 'Palmtop PCs', such as HP's little 95LX from 1991, plus others from Poqet and Sharp. These typically MSDOS-powered computers delivered dot-matrix screens, QWERTY keyboards and on-board software, making them more useful business tools – but still no audio. Most of these devices featured low-power 8086-class CPUs running at less than 10MHz – not enough to sustain data throughput for 16-bit sound.

#### Toshiba Libretto

This lack of CPU processing power, in addition to on-board storage, were key roadblocks preventing early mobile devices offering digital audio. The desktop PC was the first consumer-grade computing device to receive 16-bit stereo sound, thanks to the arrival of Creative Labs' Sound Blaster 16 ISA sound card in 1992. That year, chip makers Intel and AMD were still in the trenches over various iterations of the 80486 CPU – Intel's famed Pentium processor was still a year away.

However, squeezing existing audio tech into a mobile device was still very optional – for example, DOS-based laptops of the era, such as the IBM ThinkPad 350 from 1993, didn't include audio at all.

It wasn't until the impending launch of Microsoft's Windows 95 operating system that laptop manufacturers accepted the growing scope of multimedia and new laptops began routinely featuring a 3.5mm stereo headphone socket. Considering the original CT1740 Sound Blaster 16 card itself was around 22cm long, shrinking the tech to fit was a fair effort in its own right.

Nevertheless, the early-1990s saw the emergence of the



Left: The HP95LX delivered a compact DOS-class computer – and a really big user manual.

'subnotebook' market and one of the smallest notebook PCs ever seen in Australia appeared in 1996 in the form of the Toshiba Libretto 50CT. Combining an Intel Pentium-75 CPU and Windows 95 OS, the 50CT wasn't that much larger than many of today's big-screen phones, measuring just 210 x 115 x 34mm. Yet it featured an 810MB hard drive and a smaller 2.5mm stereo headphones socket capable of 16-bit stereo sound. Unfortunately, compressed-audio playback options were limited (WinPlay3

was the only Windows app to then play MP3 files), so the space-hungry Pulse-Coded Modulation (PCM) format was the only practical option until 1997. Nevertheless, it highlighted just how small the technology was

now becoming.

#### Microsoft's PocketPC

The year after the Libretto 50CT's arrival (and possibly in response to it), Microsoft launched its first mobile computing standard, dubbed the 'Handheld PC'. It also debuted a new mobile-focused operating system called Windows CE. Full-QWERTY keyboards and coloured LCD screens powered by new ARM-class CPUs also improved battery life considerably. HP's Jornada 720 was a fair example.

However, the Handheld PC still didn't take with the market. Nevertheless, Microsoft worked

with hardware manufacturers and rebuilt the platform, ditching the QWERTY keys and borrowing the touchscreen concept from the Apple Newton (and more recently, the hugely-successful PalmPilot).

Now dubbed 'PocketPC', it arrived in April 2000. PC maker Compaq was a key PocketPC partner, but the shock merger between Compaq and Hewlett-Packard in 2002 saw the Compaq brand retained for a short time, before being replaced with 'HP iPaq' branding. They were also affordable – my HP iPaq H1930 cost under \$400 and came with the one piece of software I used more than any other.

#### Windows Media Player

It had been available for Windows operating systems going right



Left: The Apple iPhone – what was the fuss all about?



**Right:** The HP Jornada 720 was a Windows CE handheld computer.



back to Windows 3.1, but one of the most important apps for digital audio in general, and the PocketPC in particular, was Windows Media Player. The combination of external storage availability (typically CompactFlash or SecureDigital flash cards) and now on-board MP3 and WMA audio-compression or 'codec' support meant that you could now listen to music while taking notes or doing other things on the device. The iPaq H1930 was my traveling oasis for a number of years – I could write story ideas as notes while listening to music on a device much smaller than a laptop, something I couldn't yet do with an iPod.

In that regard, Windows Media Player helped create a complete shift in mindset – for more than 100 years, listening to music was a function requiring a dedicated device. Now, it was just another app. Sure, Media Player wasn't the only app of its type (anyone still using Winamp?), but it was all but guaranteed to appear on every PocketPC device. In this case,

familiarity bred content.

But if there was a feature that tended to polarise users with most PocketPCs, it was the stylus-required touchscreen. The screen's touch technology was 'resistive', which meant it required considerable physical pressure to activate a particular spot and since the screens were also pretty small (and on-screen keyboards even smaller), a stylus was the only real solution.

By comparison, a genuine 'touch' screen required a more-sensitive 'capacitive' layer that used the capacitance effect of your finger against the screen's touch layer. This tech's day was still to come.

#### What are we waiting for?

However, as the 2000s progressed, more of us were carrying more than one device in our pockets – you had a mobile phone ('feature phone'), your MP3 player and increasingly, we were using PDAs (whether PocketPC, PalmPilot or whatever). It had become obvious that the killer product would be an easy-to-use

stylus-free PocketPC-style 'personal digital assistant' (PDA) that could play music and make phone calls. However, the barriers to overcome, though, were substantial.

Not least of which was limited battery power. Feature phones were everywhere, sure enough, but still required considerable electrical power to handle the phone's transceiver (transmitter/receiver) unit. Combining that into a 'smart' phone with CPU, storage, screen and the rest would take skill.

Another issue was the availability of a suitable CPU. On the whole, single/limited-function devices like mobile phones and MP3 players utilised at best resource-limited power-efficient microcontroller technology, rather than an expansive general-purpose high-performance CPU. However, that's exactly what was now required – and in 2005, CPUs that delivered decent performance on a bare sniff of electrons were still pretty thin on the ground.

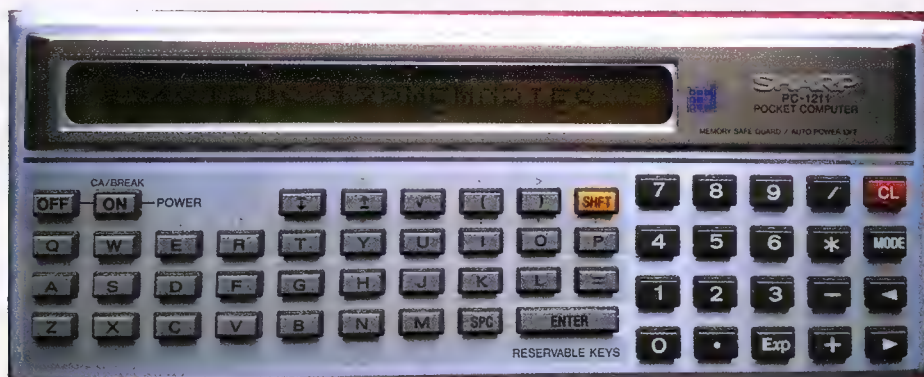
Nevertheless, chip designer ARM had cut its teeth on the Apple Newton and over the last 20 years had slowly built up its CPU tech portfolio. In 2005, the company announced the first of its new Cortex-A CPU family, dubbed the 'Cortex A8'. Apple instead chose a Samsung version of the previous-generation ARM11 CPU core. Apple also underclocked the chip from its standard 620MHz to 412MHz to reduce power consumption. However today, the ARM Cortex-A series rules the world.

By the time Apple boss Steve Jobs pulled the iPhone out of his jeans-pocket on its announcement day of 9 January 2007, it was the nexus of multiple technology strands all reaching sufficient maturity at the right time – capacitive-LCD panels, mobile CPU design, flash storage capacity, Lithium-ion battery technology, internet connectivity, RAM chip capacity, chip fabrication methods. All of these technologies had to reach just the right level to make the iPhone a practical reality.

#### Smartphones and earphones

Today, the combination of smartphone and wireless earbuds is the uniform-of-choice of travellers around the world, whether it's walking to work, hitting the bus, the train or the plane. Audio quality is all but indistinguishable from the original live instruments and the idea of storing music locally on your

**Below:** The Sharp PC-1211 was the first programmable computer that fit into your pocket (Image credit: Denisfo, CC BY-SA 3.0).







device is 'so 2010s', particularly when streaming services can provide access to almost any song streamed via your phone-network provider.

Like the MP3 player and Walkman before it, look at an original first-generation iPhone today and it, too, with its tiny screen, has aged by today's standards. But in the 16 years since, not much has changed – phones are bigger, faster, run longer and do more, but the same basic building blocks are still there. Let's hope in another 40 years, future generations look back at how primitive it all is.

#### What goes around...

That said, today's smartphones do make it ridiculously simple to dial up and play almost any song ever written. But in losing much of the complexity of listening to our favourite music, we've also lost a fair bit of what I'd call the 'theatre' of playing recorded music. In much the same way the clash of rods and pistons and steam of a steam train captures the imagination of young and old alike, there's a bit of magic and anticipation involved when you pull out an LP, reel of tape or cassette, load it into what now looks like some weird retro-electromechanical time-machine, operate its controls and levers, watch it spin up and hear the dulcet tones of your favourite musicians emanate. But like the steam train, it's probably an idea that belongs to another time.

Over the last six issues, we've traced a potted history of portable audio – from the early days of luggable valve radios to carry-able reel-to-reel tape recorders, the invention of the compact cassette,

the compact disc, flash storage, iPod and iPhone.

Yet in the face of this rapid cascade of new tech, there have been recent reports of younger generations discovering technologies of generations past, including cassettes and digital cameras. Brush it off as just a case of

'early-onset nostalgia' if you like, but I reckon there's an innate desire in all of us to understand more of our technology, or to at least feel a little more in control of it.

Nevertheless, music helps us to react and feel, to forget and remember, as it has done since the dawn of time – and for 100 years come December this year, as we celebrate the centenary of broadcast radio in Australia, we've been using technology to do much the same.

"It had become obvious that the killer product would be an easy-to-use stylus-free PocketPC-style 'personal digital assistant' (PDA) that could play music and make phone calls. "

#### Next month... a new series

Next issue, we begin a brand-new series taking a uniquely-Australian look at one of the most glorious eras of computing – the golden 1970s-80s age of the 'home computer'. We'll rediscover some of our rich but almost-forgotten history, of a

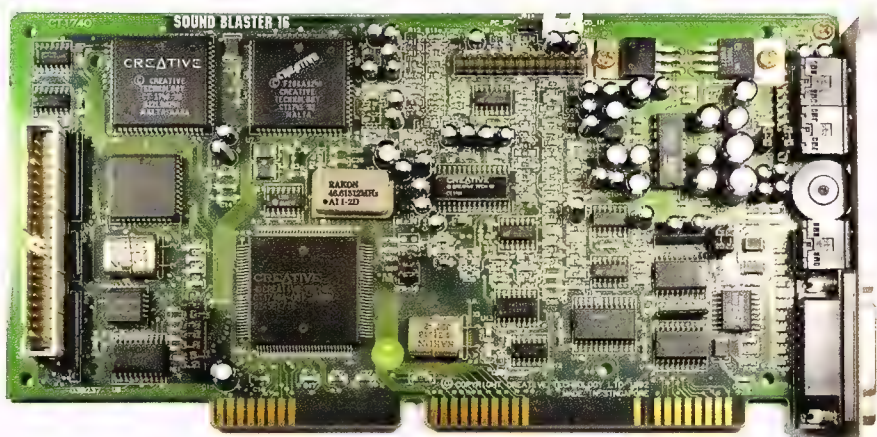
time when Australia was a pioneer in home computing, before either Apple or Microsoft appeared on the scene. We'll cover some of the blockbuster computers of

the era that stormed the local market, but we'll focus on some of the lesser-known home-grown marvels that not only made an impact on Australian shores, but helped shape home computing in Australia. I can't wait for this series and I hope you can join me then. ■

Above left: More than 25 years on, the Toshiba Libretto is still one of the smallest PCs ever built (Image credit: Lorenzo Breda, CC BY-SA 3.0).

Above: The T-Mobile G1 (HTC Dream) launched Android to the world a year after the iPhone (Image credit: Michael Oryl, CC BY-SA 2.0).

Below: How do you squeeze this into a phone? Creative Labs' CT1740 Sound Blaster 16 sound card (Image credit: Darren Yates).

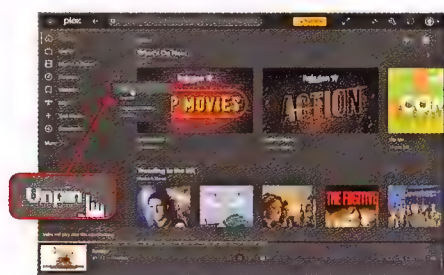




# WHY YOU SHOULD DITCH plex

Plex is a brilliant way to stream audio and video content, but it's recently made some unwelcome changes. Robert Irvine explains what they are and what to use instead.

Plex ([www.plex.tv](http://www.plex.tv)) has long been one of our favourite ways to organise and enjoy our videos, music, photos and other media files on any device. But recently the company has made a few decisions that have disappointed many users, and led to us looking for an alternative streaming service that doesn't suffer the same problems. Here we explain why you might consider ditching Plex, and what you should use instead.



Plex's interface has become cluttered, but you can 'unpin' any unwanted sections.

## WHY YOU SHOULD DITCH PLEX

### PLEX HAS DROPPED SUPPORT FOR OLDER PCS

After 10 April, Plex will no longer support computers that run Windows 7 and 8.1. The latest version of its Media Server software (1.32) will only work on Windows 10 and 11 PCs, and though you'll still be able to use previous versions on an old machine, they won't receive security and feature updates.

"While older versions of the Server may continue to run in these now-unsupported environments for the time being, we encourage everyone to upgrade their systems to at least Windows 10 (version 1607)," said Plex in a forum announcement ([www.snipca.com/45526](http://www.snipca.com/45526)).

In fairness to Plex, it's not the only software company to abandon Windows 7 and 8.1 since Microsoft ended support for them in January. If you have Plex Media Server installed on an old PC, you'll still be able to use the software, but it won't be protected against the latest security threats and performance issues.

### PLEX HAS SUFFERED SERIOUS DATA BREACHES

Last August, Plex confirmed that it had been affected by a security breach and warned its users to change their passwords ([www.snipca.com/45527](http://www.snipca.com/45527)).

A hacker was able to access user data including email addresses, usernames and passwords – but not payment-card details. Plex said only a "limited subset" of accounts were compromised, and that the stolen data was "hashed and secured in accordance with best practices".

Plex was quick to react to the hack, issuing a software patch that fixed the problem, and notifying users within 24 hours, but it's not the first time its security issues have made the headlines.

In early 2021, it was discovered that hackers were exploiting security flaws in Plex Media Server to carry out DDoS attacks ([www.snipca.com/45529](http://www.snipca.com/45529)). Around 27,000 devices running Plex software were found to be exposed, and though it also fixed this flaw quickly, both instances may make you question Plex's "best" security practices.

### PLEX MAKES YOU PAY FOR ITS BEST FEATURES

Although Plex gives you plenty of features for free, including the ability to set up a media server, stream music and video to PCs and smart TVs, and watch ad-supported TV shows, films and live channels, some of its best options require you to pay.

Most notably, if you want to watch or listen to media files you stream to your mobile device for more than one minute, you must either pay \$5 or subscribe to a Plex Pass. This costs \$6.49 a month or \$49.99 a year, and is also needed to record live TV, sync content across devices, download music and videos to play offline and more.

It's difficult to begrudge Plex for funding its business by limiting features to paying users, especially when it offers so much for free. But you may still find it frustrating that a Plex Pass is required for certain tasks, and that there isn't a free trial.

### PLEX'S INTERFACE IS BECOMING BLOATED

While Plex restricts certain features to paying users, its free software is becoming cluttered with content you may find unnecessary. The Home screen now includes several rows of recommended and recently added TV shows and films, while the Music section heavily promotes the Tidal music-streaming service.

Last year, Plex added a Discover option, which lets you find things to watch across different streaming platforms. Although this is potentially useful, it also wastes space – and your time – by recommending titles that aren't available on services you use.

Although you can customise Plex's interface to remove unwanted sections – click the three-dot icon and choose Unpin



(see screenshot below left) – it's a shame the company has moved away from its original purpose of letting you curate a personal media library.

**WHAT TO USE INSTEAD OF PLEX**  
**JELLYFIN**

[www.snipca.com/45534](http://www.snipca.com/45534)  
If your main reason for using Plex is to stream your own media files to different devices, Jellyfin is the ideal alternative. This open-source program is completely free to use, with no options restricted to a paid-for plan (because there isn't one), and has a streamlined interface that isn't cluttered with promotions for other services.

Jellyfin works in the same way as Plex – you install its media server on your Windows, Linux or macOS computer, then install 'client' apps on other devices so you can stream content to them, either over your home network or the internet. These include apps for Android and iOS; the smart-TV platforms Google/Android TV, Roku, Fire TV and WebOS; as well as the Jellyfin Media Player for desktop PCs. You can see how its interface looks by visiting the Jellyfin Demo (<https://demo.jellyfin.org>) and logging in with the username demo (you don't need to enter a password).

Download the Jellyfin server software from [www.snipca.com/45537](http://www.snipca.com/45537), and choose the Basic Install option. Select 'Jellyfin (View Console)' in your Start menu to open a Command Prompt window and install the required services – you may need to allow Jellyfin to connect through your firewall. Right-click the icon in your system tray and choose Open Jellyfin to access the server in your browser and set up your media libraries.

You can import folders containing movies, TV shows, music, photos and audiobooks (see screenshot below left), and have Jellyfin detect when new items are added to them. The software can detect and download metadata and artwork, so content you've downloaded or copied from other sources has the correct information.

It also lets you install plug-ins ([www.snipca.com/45535](http://www.snipca.com/45535)) to get extra features such as watching and recording live TV on

supported hardware.

Although Jellyfin isn't quite as simple to use as Plex, it provides plenty of online documentation ([www.snipca.com/45536](http://www.snipca.com/45536)) to get you started and help you make the most of the software. It can also be installed on a Synology NAS drive, though this requires a degree of technical knowhow.

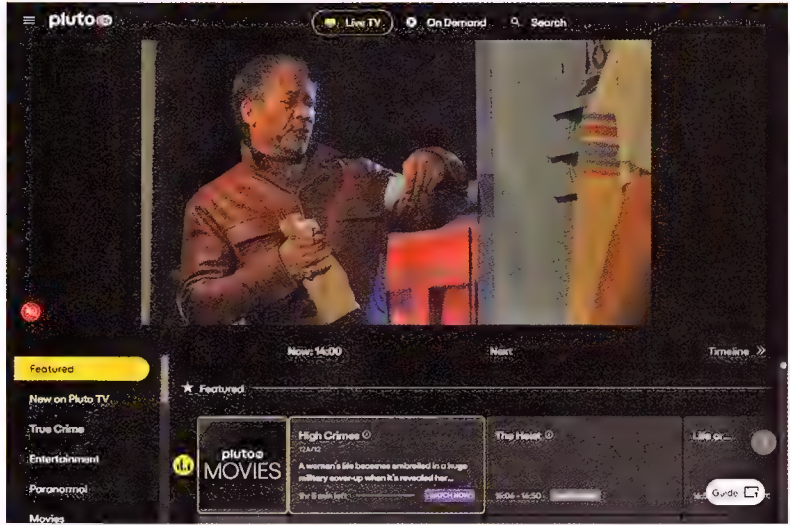
**KODI**  
<https://kodi.tv>

Kodi has several advantages over Plex as a way to manage and enjoy all your media files in one place. It's open-source and entirely free; it's maintained by a passionate community, not a commercial business; and it offers a range of customisation options so

you can tailor it to the device you use it on, be it your PC, Android phone or tablet (it only works on jailbroken iOS devices) or smart TV.

Adding music, videos and photos to Kodi is a breeze, whether they're stored on your device, an external hard drive connected to your computer or removable storage such as an SD card or USB stick. You can also stream media from any networked PC, though this isn't as easy to set up as with Plex and Jellyfin.

Kodi is famous – and infamous – for its support for add-ons (see screenshot below). Those you install from its own Add-ons store ([www.snipca.com/45538](http://www.snipca.com/45538)) are perfectly legal, but beware of any dodgy add-ons you find online, which may illegally stream copyrighted content for free. ■

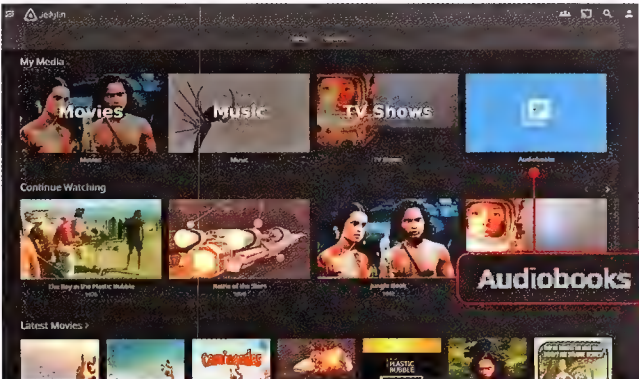


**STREAM TV AND FILMS FOR FREE**

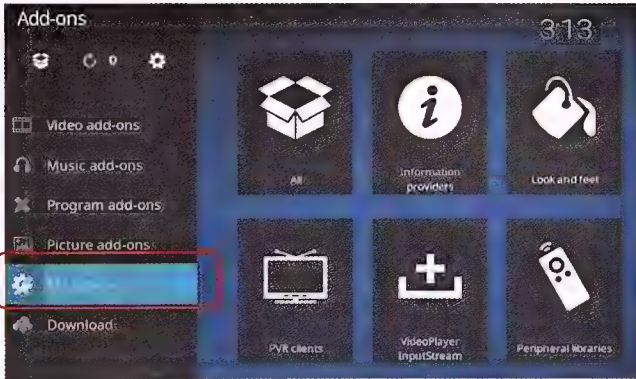
If you mostly use Plex to stream its films and TV shows, rather than your own content, there are a couple of good free alternatives.

Pluto TV (<https://pluto.tv>) is free to watch, offers more than 250 live channels (more than Plex), including 16 dedicated to films – and you don't need an account to tune in. You can either browse the TV guide for something good to stream now, or watch programmes on-demand. Pluto TV is available in your browser (pictured), and as an app for smart TVs, and Android and iOS devices.

We also like Rakuten TV ([www.snipca.com/45545](http://www.snipca.com/45545)) which has loads of free and good-quality TV shows and films to watch on demand, as well as more than 100 live TV channels, spanning categories including news, sports and music.



Jellyfin lets you add and stream media files, including movies, music, TV shows and audiobooks.



Add extra features to Kodi using add-ons, but make sure you stick to legal options.



# DON'T GET HACKED IN PUBLIC

Using a VPN is a great way to stay safe on public Wi-Fi, but you should also tweak security settings on your phone, tablet and laptop. Daniel Booth explains which options to turn on and off.

## Use random hardware addresses to stop Wi-Fi tracking

When your laptop isn't using Wi-Fi it looks for networks nearby to connect to. It does this by sending a signal that contains its MAC address. Because this address is unique to your device, some public areas like shopping centres could use it to track your movement.

You can block this by getting Windows to generate random MAC addresses, concealing your real one. There are two ways of doing this – either across all Wi-Fi networks (for maximum security), or on specific networks. To do the former in Windows 10, open Settings (press Windows key-I), then click 'Network & Internet' followed by Wi-Fi on the left (1 in our screenshot below). Now click the 'Use random hardware addresses' slider so it turns blue (on) (2).

For a specific network, click 'Manage



Turn on 'Use random hardware addresses' to stop anyone tracking your movements via Wi-Fi.

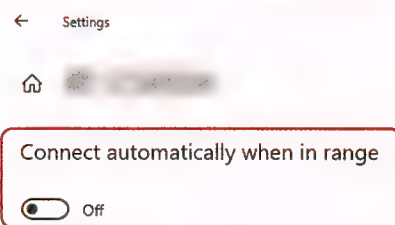
known networks' on the Wi-Fi page. Now click a network on the left, then Properties, and change the 'Use random addresses for this network' dropdown menu to On or 'Change daily'.

If you can't turn on Random Hardware Addresses, it may be because your Wi-Fi card doesn't support it. There's no definitive list of cards that are compatible, but you can do your own research by checking which card you're using. Search for and open Device Manager on your computer, then click the Network Adapter menu and look for the adapter – it should have Wi-Fi 5 or 6 in the name.

## Stop your devices connecting to Wi-Fi automatically

If you visit many different places with Wi-Fi networks, you should make sure your laptop doesn't connect to them automatically. The easiest way to do this in Windows 10 and 11 is to click the Wi-Fi icon in the taskbar, then select the network name, and untick 'Connect automatically'.

If that doesn't work – or Windows continues to connect you automatically – open the Wi-Fi section in Windows Settings, as explained in the previous tip. Now click the Wi-Fi connection you're currently using and turn off the 'Connect automatically when in range' slider (see screenshot above right).



Turn off this option to prevent Windows connecting you automatically to a network.

You can also 'forget' Wi-Fi networks that require passwords. This will prevent your laptop from remembering the password, and therefore from automatically connecting. Click 'Manage known networks' in the Wi-Fi section of Windows Settings, then right-click the network and click Forget. Right-clicking the network from the taskbar also shows the Forget option.

On your iPhone, open Settings, then tap Wi-Fi followed by the small blue 'i' next to your network's name. Now tap the Auto-Join slider to turn it off. On iPads, tap Settings, Wi-Fi, then turn off the Auto-Join Hotspot slider.

Instructions will vary in Android depending on the phone or tablet you have, but generally open Settings, then tap 'Network & Internet' followed by Wi-Fi. Now tap 'Wi-Fi preferences' and turn off the 'Connect to public networks' option. If your device doesn't have these options, look instead for sections called Mobile Networks or Connections.



☒ Connect automatically when in range

Network profile type

☒ Public network (Recommended)

Your device is not discoverable on the network. Use this in most cases—when connected to a network at home, work, or in a public place

☐ Private network

Your device is discoverable on the network. Select this if you need file sharing or use apps that communicate over this network. You should know and trust the people and devices on the network.

Windows 11 selects all new Wi-Fi networks as Public by default.

## Disable file sharing on your laptop

When you're using your laptop at home it might be convenient to share PC files or printers with members of your family who are using other machines. You can do this in Windows by setting your computer as Private, indicating that you're on a trusted network. However, you're less likely to want to grant this privilege to the person serving you a cappuccino or a pint of bitter, so set your computer as Public when leaving the house.

Windows 11 automatically sets your computer to Public network when you first connect to a network – check by opening the Wi-Fi section in Settings as described in previous tips, then clicking the network you're connected to. You should see that 'Public network (Recommended)' is selected (see screenshot above). It's the same process in Windows 10, but you'll notice that it doesn't select Public by default – nor is it shown as the recommended option.

You can double-check whether Windows is treating your computer as private or public by searching for and opening Control Panel, then clicking 'Network & Internet' followed by 'Open Network and Sharing Centre'. You'll now see the Wi-Fi network you're connected to and its status below.

## Block hackers accessing your Bluetooth

Your Bluetooth can be hacked in three ways. In order of seriousness these are: Bluejacking, Bluesnarfing and Bluebugging. Bluejacking is when someone nearby sends you an unexpected message via Bluetooth. These can be distressing particularly if they're abusive – but they don't install any malware on your device.

Bluesnarfing is not a banned Roald Dahl word, but the hacking of

Bluetooth connections to steal sensitive data such as passwords, contacts and images. It's hard to detect, so could be happening for a long time before you notice.

Bluebugging is the most dangerous because after hacking into your device criminals can install 'backdoor' malware that allows them to repeatedly access and control it whenever they like. They can also listen to your calls, and even reply to your text messages.

Leading Bluetooth developers claim signals can stretch over a kilometre, but in practice they usually cut out after about 10 metres. Bluetooth attacks are therefore carried out by criminals in the street, coffee shop or pub, not shadowy gangs thousands of kilometres away in China, Russia or North Korea.

Turning off Bluetooth in your device's settings when you don't need it neutralises these attacks with one tap. But if you want to keep using Bluetooth, you can minimise the risk by preventing other devices from discovering yours.

In Windows 10, open Settings (press Windows key-I), then click Devices, followed by 'Bluetooth & other devices'. You'll see here whether your Bluetooth is switched on (1 in our screenshot below). Now click 'More Bluetooth options' (2 on the right and untick 'Allow Bluetooth devices to find this PC' (3). Also make sure that 'Alert me when a new bluetooth device wants to connect' is ticked (4).

In Windows 11, open Settings, click 'Bluetooth & devices' on the left followed by Devices in the middle. Scroll down and click 'More Bluetooth settings' and untick the same option as above.

## AVOID 'EVIL TWIN' WI-FI NETWORKS

In 'Evil Twin' attacks, hackers can create fake Wi-Fi networks using names that are similar to real networks. The differences can be subtle, such as an upper-case letter instead of lower-case, or a closed-up phrase. So if the genuine public network is CityCafe\_WiFi, but you've logged into CityCafeWiFi, then you've been trapped by the twin. To avoid this, ask someone working there what the correct network name is or, better still, get them to write it so you can check the spelling and specific phrasing.

< General AirDrop

Receiving Off

1

Contacts Only

2

Everyone for 10 Minutes

3

You can stop receiving AirDrop files or restrict them to your contacts.

On Android, go to Settings, Location, 'Wi-Fi and Bluetooth scanning' and disable 'Bluetooth scanning'. On an iPhone or iPad, you'll need to turn Bluetooth off altogether.

Apple's AirDrop file-sharing technology also uses Bluetooth, so don't accept anything unexpected sent this way. You can eliminate the risk on your iPad or iPhone by tapping Settings, followed by General, AirDrop, then tapping Receiving Off so a blue tick appears (1 in our screenshot above).

There's also an option (2) that prevents anyone outside your contacts list from seeing your device as somewhere they can send AirDrop files to. Tick this if you want to receive file requests only from people you know.

In iOS 16.2, released in December, Apple added the option to allow AirDrop requests from 'Everyone for 10 Minutes' (3). After this period, it reverts to contacts only. There's no option to make Bluetooth itself undiscoverable in iOS.

As a general rule, when you first pair a device make sure you do it at home, not in a public place. This is to make sure hackers don't detect your Bluetooth while you've made it discoverable to pair with a device for the first time. If you lose a device you previously paired with, make sure you remove it from your list of paired devices. ■

Untick 'Allow Bluetooth devices to find this PC' in public to stop other people pairing with your laptop.

Bluetooth

On

3 ☐ Allow Bluetooth devices to find this PC

More Bluetooth options

2

☒ Alert me when a new Bluetooth device wants to connect

4



LCD, mini-LED or  
OLED – which  
deserves to be in  
your next monitor?



FEATURE

# The flat panel pipeline

*Jeremy Laird investigates flat panel technology and lifts the lid on what you can expect in the near and not-so-near future.*

Be careful what you ask for – you might just get it. So it goes with screen technology of late. We've been clamouring for something better than an LCD panel with a big, dumb backlight for years. Now we've got it, and it turns out – in some ways, at least – that conventional LCD monitors aren't so bad after all.

The new entrants on the display scene are, of course, mini-LED and OLED. Mini-LED screens are actually a subset of LCD displays, not a new category of panel tech. But they do represent a

significant step change. OLED, meanwhile, has taken its time transitioning from the TV market to PC monitors. But it is a radical new technology and has finally arrived in desktop monitors.

On paper, both offer dramatic advantages over conventional LCD displays. At last, you can have true HDR performance, per-pixel lighting, rapid response times and several other hitherto unobtainable screen attributes.

In practice, however, they are turning out to be rather more problematic than

initially predicted.

Put it this way: we've seen numerous examples of the latest mini-LED and OLED monitors, and we're not sure we'd take any of them over the best available conventional LCD panels.

There are a couple of caveats to that, which we'll come to. But along the way, we need to identify what exactly the problems with mini-LED and OLED monitors are, ask if they can be fixed and consider if there are any alternative technologies that entirely sidestep all the issues. Let's get to it.





"At last, you can have true HDR performance, per-pixel lighting, rapid response times and several other hitherto unobtainable screen attributes. In practice, however, they are turning out to be rather more problematic than initially predicted."



We've mentioned this before in previous issues, but LCD is a fundamentally borked technology when it comes to displaying full colour motion images. In fact, it's so bad that you have to give credit to the engineers who polished what is ultimately a flat panel turd into the dominant display tech it has become today.

So let's start by recounting the many ways in which LCD technology is unsuitable for use as a modern display solution for computing. For a start, it's transmissive rather than emissive, meaning that you need a separate light source to push photons through the pixels.

This is problematic on several levels. First, you have to choose between a single big, dumb backlight and something more complex that allows some kind of local lighting control. The more precise the local control, the more complex and costly your light source becomes.

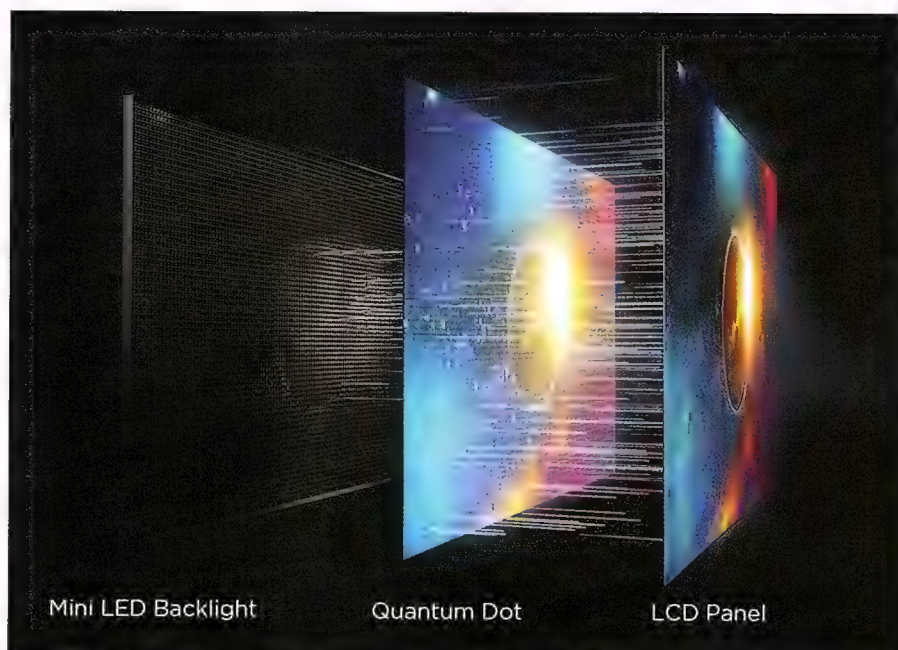
Second, the idea is that the liquid crystals in those eponymous panels – LCD stands for Liquid Crystal Display – can change orientation and thereby control the amount of light that passes through a given pixel to be controlled. However, that control is imperfect.

On the one hand, that means a little light leaks through, even if you don't want it to. That's why conventional LCD panels have such poor contrast and black levels – it's that unintended light leakage spoiling everything. On the other, the physical characteristics of those crystals mean that the amount of light that passes through also depends on the angle at which you view them, so depending on where you are sitting in relation to the screen surface, the brightness and colours can change. Taken altogether, that means bad things for black levels, contrast and viewing angles.

Those liquid crystals have more to answer for, however. Because the technology involves the movement of physical crystals, that inevitably takes time. That's known as the response time, and it's much slower for LCD than a truly solid state technology like LED, which responds almost instantly.

These days, monitor makers claim LCD response times of 1ms or even 0.5ms. But those metrics are misleading and only measure part of the transition process from one colour to the next. In reality, the full response time for even the fastest LCD panels is around 10 times slower – slow enough, in other words, that the response is detectable by the human eye in the form of blurring and smearing. That's true to an extent, even with the very latest and fastest LCD panels.

If those are the baked-in issues with



Mini-LED is still fundamentally a transmissive technology using LCD panels.

LCD tech, the solutions are mini-LED and OLED – at least, that's the theory. Mini-LED isn't actually a brand new display tech, but really an improved backlighting solution for LCD panels. The way it works makes a lot of sense. Instead of a monolithic backlight, mini-LED is composed of an array of zones that can each be individually controlled. The idea of local dimming zones isn't unique to mini-LED, but mini-LED takes that approach and really runs with it. Currently, mini-LED monitors are available with as many as 1,000 or more zones, far more than previous local dimming applications.

The benefit of all those zones is the ability to adjust the backlighting to suit the image being displayed, so the zones

behind bright objects can be ramped up, while those behind darker areas can be wound down, dramatically increasing contrast. It's even possible to achieve true black levels by switching zones off.

At least, that's the theory. In practice, mini-LED is still a pretty crude lighting solution. Take a 4K mini-LED monitor with 1,152 zones. The problem is that a 4K panel has over 8 million pixels, so each zone lights up 7,200 pixels. But the fine details in images might only be a few pixels across and involve maximum brightness next to completely black.

An example is text, the lines and curves of which contain very small pixel counts.





Mini-LED has no good way of dealing with that any more than a panel with a single, monolithic backlight does. Even with thousands of zones, you're going to find that several words fit inside a zone. You're nowhere near being able to light up individual letters.

In practice, then, mini-LED has some major issues. On the Windows desktop, you get all kinds of oddities. You can see the zones popping on and off as you move windows and apps around, and visible lighting gradients are often visible across blocks of text if one side of the text is near a much brighter or darker screen element than the text itself is situated in. If it was a normal monitor, you'd think it was broken.

Admittedly, the problems are less obvious in games and movies, and the best mini-LED panels are capable of incredible brightness up to 1,600 nits or more. But the bottom line is that mini-LED panels involve compromises. The effective resolution of the dimming zones is so much lower than the image displayed that there are always trade-offs.

In games and video, that can mean a loss of detail in darker areas of rendered images as the zones behind them are turned down and the subtleties are crushed. Likewise, blooming around bright objects can also be seen as the zones are cranked up, but don't quite match the shapes of objects and text.

And of course, mini-LED does nothing to fix the response and viewing angle shortcomings of LCD. However, there is a panel tech that promises a solution to those things as well as avoiding the compromises of local dimming arrays. Yes, it's OLED and it fixes absolutely everything. Or does it?

The most obvious benefit of OLED is that it's an emissive screen technology. That means it doesn't need a backlight at all. Each pixel – indeed, each subpixel – is its own light source. OLED is the real per-pixel lighting deal. You can have a completely switched off, fully black pixel right next to one running at full brightness. No blooming, no trade-offs; just perfectly controlled contrast and true black levels.

As a truly solid-state technology, OLED is faster than LCD and can achieve true on-off performance well below 1ms. Most OLED monitors are quoted in the 0.1ms to 0.03 ms range, making them more than an order of magnitude faster than LCD. So that's it – OLED is the way, the truth and quite literally the light, right? Sadly not.

The best-known issue with OLED tech is image retention – or burn-in. The problem relates to the fact that the red, green and blue subpixels in an OLED panel wear out at different rates. The blue subpixels wear out faster than the red and green subpixels. Over time, that can cause the panel to lose overall color accuracy.

What's more, let's say the panel is displaying a pure green object at 500 nits. That will require 500 nits predominantly from the green subpixels. But a white object, also displayed at 500 nits, will use all three subpixels, sharing the load.

In other words, the wear rate on the subpixels varies according to the colours being rendered. If you render a bright blue object for an extended period, that's the worst possible scenario. If you display such a high-wear visual object on the screen for long enough, the pixels rendering it

will wear more than others, and that can permanently shift their colour balance compared to pixels around them, resulting in that image or object being “burned” into the panel permanently.

OLED technology has been developed over the years to reduce the risk of burn-in. Several mitigating technologies, such as image shift, have been implemented to the extent that burn-in isn't much of an issue for TVs. Image shift works by over-provisioning pixels or resolution such that the image can be shifted slightly across the panel without cropping the picture.

Almost all recent OLEDs have what's known as compensation cycles, also known as pixel refresh cycles. In simple terms, wear levels across the panel during normal usage are registered. The refresh cycles run at set time intervals, displaying image patterns that drive the pixels with colours that even out the wear.

Most screens have two different compensation cycles: a short one that runs frequently, typically every four hours or so, and a more intensive cycle that will run after 2,000 hours and takes longer to complete. Anyway, as a consequence of these measures, burn-in isn't a major problem with the latest OLED TVs. It's yet to be seen how well the new generation of OLED monitors will fare. We'll only know for sure how well panels in PC monitors last once they've been around for several years, but early indications are good.

Speaking of subpixels, another problem with OLED tech is subpixel structure. The vast majority of LCD monitors use the standard RGB or red, green blue subpixel structure where

Alienware's 34-inch model is about as good as OLED gaming monitors currently get.



The Corsair Xeneon Flex is a 45-inch beast of an OLED monitor but suffers from pretty much all of the technology's shortcomings.





## THE ULTIMATE DISPLAY TECH MICROLED HAS JUST ONE PROBLEM. . .

It's the perfect display technology. There's just one problem: you can't buy it, at least not in a form relevant to the PC. That's the problem with microLED — it may as well not exist unless you need a massive display for a public installation.

So why can't you get it in a PC monitor? First, let's review why you'd even want it. Like OLED, microLED is a self-emissive technology. Each pixel being its own fully switchable light source, so you can have a fully "off" pixel right next to one running at full brightness, giving perfect lighting control and effectively infinite contrast.

However, unlike OLED, microLED sidesteps the organic compounds that translate into so much pain when it comes to image retention and burn in. What's more, microLED might be even faster than OLED, which itself is at least an order of magnitude quicker than LCD.

At CES earlier this year, Samsung claimed that its latest microLED tech clocked in at just two nanoseconds for response time. That compares with the claimed 0.1ms pixel response of Alienware's 34-inch OLED gaming monitor, which of course uses a Samsung Quantum Dot OLED panel.

If nanosecond versus milliseconds doesn't mean anything to you, it's worth taking note of the gap between the two metrics. A millisecond is one thousandth of a second, but a nanosecond is one billionth of a second. That huge difference means Samsung is claiming its microLED panels are 50,000 times

faster than its OLED panels.

So microLED sounds amazing, right? Indeed, but it's nowhere near appearing in PC monitors. The first problem is pricing — it's crazy expensive. That's because of current manufacturing techniques that involve "pick and place", in which each LED has to be individually installed on the microLED backplane.

When you consider that a 4K panel has 8 million pixels, that's a lot of picking and placing, which is time consuming despite being done by a machine. The pick and place process also creates another limitation: pixel density. The individual LEDs can only be located so close to each other when being mounted individually.

A couple of years ago, the smallest 4K microLED display was 110-inch. Samsung has since shrunk microLED panel proportions a bit. But they're still up at 70 inches and over — nowhere near an ergonomic size for a PC monitor. Samsung does produce microLED displays in the 50-inch range, but they are sub-4K resolution and offer poor pixel density. The likes of a 32-inch 4K microLED remains years away.

So there you have it. MicroLED promises so very much. It almost certainly will end up being the next really big thing in display technology and will be the ultimate in flat-panel 2D screens. But sadly it's also several years away from being used in even very high end PC monitors, let alone mainstream and affordable models.

each pixel is made of three vertically orientated or striped subpixels in those colours and in that order, left to right. Not so with OLED.

Currently, there are only two players in the OLED panel market: LG and Samsung. Almost every PC OLED monitor on sale, with the exception of some niche displays for professional markets, are based on panels from one of those manufacturers, and neither makes OLED panels with a conventional RGB subpixel structure.

Samsung's OLED panels, as seen in the Alienware 34 AW3423DW and several other 34-inch ultrawide models from brands including MSI and Samsung itself, use a triangular subpixel structure, rather than vertically striped. LG's OLED subpixels, meanwhile, are arranged vertically like a conventional LCD, but in an RWGB arrangement where the "W" is a white subpixel inserted to improve brightness.

For games and video, the precise subpixel structure doesn't matter. However, for computing it does. Windows addresses pixels at the subpixel level to make fonts smoother and crisper, effectively increasing the resolution of a display and allowing for sharper, cleaner fonts. However, this only works on pixels with an RGB subpixel structure. Windows can be set to render to BGR pixels.

However, that only works for the Windows interface and Microsoft's home-grown browser. Many applications, including the Chrome browser, do their one font smoothing and subpixel rendering and cannot be adjusted to work correctly with a BGR subpixel layout or any other non-standard subpixel arrangement.

As a consequence, fonts on OLED monitors suffer from fringing and blurriness compared to conventional RGB LCD panels. This is exacerbated by the fact that the pixel density of current OLED monitors is relatively low. Those 34-inch ultrawide panels are as good as it gets, but they only run at 3,440 by 1,440 pixels, which translates into 110DPI.

Aside from a few megabucks monitors for professional image and video editing, you can't currently get 4K OLED panels in smaller panel sizes like 27-inch and 34-inch. 4k at those screen sizes would have sufficient pixel density to mostly resolve the issues that result from non-standard subpixel structure. However, all non-pro OLED monitors are derived from TV panels, so don't have the pixel density offered by better LCD monitors. It's a double whammy for font rendering in current OLED monitors, then.



Samsung's microLED tech promises so much, but it's years away from hitting the PC.

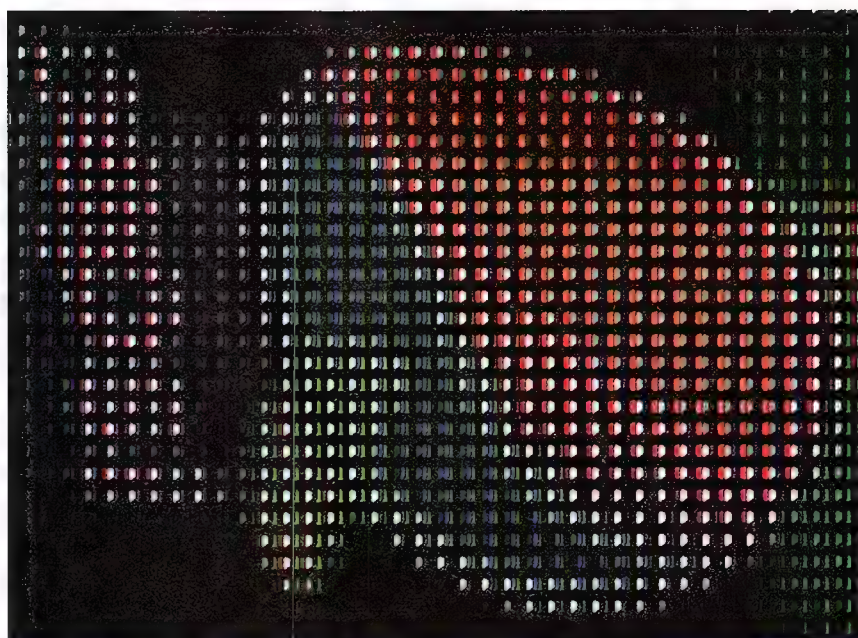


That's particularly frustrating when you consider how expensive OLED monitors are – that Alienware 34-inch panel is almost \$2,000. Similarly, LG's new OLED PC monitor, the UltraGear 27GR95QE-B, is a 27-inch 2,560 by 1,440 model that lists at \$1,799. That's a lot of cash for a 27-inch 1440p model.

The justification for the lofty pricing, of course, is that perfect per-pixel OLED lighting. But even that isn't all it's cracked up to be. The problem is brightness, or lack of it. The latest OLED monitors from the likes of Alienware, Samsung and LG are quoted as being capable of 1,000 nits or more. Indeed, cutting-edge OLED TVs increase that to over 1,500 nits. Measure them and they can indeed hit those kinds of numbers. But there's a catch. Those numbers are not for full screen brightness, but only a small patch or "window" of perhaps as much as two percent of the visible area.

When measuring what OLED panels are capable of achieving across a large area – or worse, the entire panel – the numbers are far, far lower. The LG UltraGear 27GR95QE-B can't even manage 200 nits full screen, while the Alienware 34 AW3423DW hits around 250 nits. In between those two extremes of a very small area of brightness versus full screen brightness, panel brightness essentially scales. As the ratio of bright to dark screen area increases, the maximum brightness decreases. Exactly how much that matters depends on your use case and what you are viewing.

OLED can look utterly spectacular in movies and games, especially when



The subpixel structure on OLED panels, like those of LG, aren't optimised for PC productivity.

the scene or image being shown is a mix of bright and dark areas and when there's a bit more of the latter than the former. But in brighter scenes in games and movies, OLED lacks the punch of even a good conventional LCD monitor with no local dimming, let alone the eye-popping brightness of the most powerful mini-LED monitors.

On the Windows desktop, meanwhile, OLED has its own oddities to rival those of mini-LED. Let's say you have a dark desktop wallpaper, meaning the image being rendered when you boot up is mostly dark. In that scenario, all the little details like icons and menus will really pop. However, if you then open an application like a text document or

maybe a browser in a large window that's mostly white, the screen brightness will suddenly drop. Indeed, if you resize the window manually, the brightness of the entire panel will increase and decrease as you make the window smaller and larger. It's awfully clunky, especially when you've paid extra for a supposedly far superior display technology.

For now, there's no satisfactory solution to this. OLED panels are getting incrementally brighter, bit by bit. Measures like heat sinks can allow OLED panels to run a little brighter, and LG has a new MLA micro-lens technology that is likewise said to improve brightness. But none of that stuff as yet has enabled OLED tech to

The Philips Evnia 34M2C7600MV is another mini-LED monitor with some worrying image quality issues.



Would you pay nearly \$2,000 for a 27-inch 1440p monitor? That's what LG wants for this OLED panel.





achieve high brightness when a large proportion of the panel is being lit up. LG's UltraGear 27GR95QE-B has MLA tech, for instance, but can't match Samsung's OLED panels for full screen brightness, let alone LCD monitors, which are several times brighter.

All of this means that while both mini-LED and OLED do bring some major advantages, they're also each very obviously flawed in a PC monitor context. Indeed, we'd argue that for now, a conventional LCD panel probably remains the best compromise overall. That way, you can have proper pixel density and subpixel rendering and a full choice of panel sizes, resolutions and refresh rates, often at much lower prices than the mini-LED and OLED options.

The arguable exception to that and the caveat we mentioned earlier involves mini-LED monitors. Since they are based on the same LCD panels as conventional monitors, you generally have the same broad choice of panel sizes, resolutions, pixel densities, aspect ratios and so on.

So whether it's high-DPI and nice crisp fonts or high refresh and lower resolutions for gaming, but with eye-popping brightness, you can have it all with mini-LED.

What's more, the local dimming function can usually be disabled. With this, you can run a mini-LED panel like a conventional monitor with a monolithic backlight while on the Windows desktop and avoid all the distracting issues and problems that come with mini-LED. Then, you can selectively enable local dimming for specific games or video content where it works best.

The catch is the hefty premium you'll pay for mini-LED technology that you might only use occasionally and, of course, the knowledge that you're not getting anywhere near the pixel response of OLED. As for OLED monitors, they definitely have an appeal for gaming. There's no doubting that the incredibly fast response is far superior to any LCD monitor and the limited brightness is only an intermittent annoyance. But with a general purpose monitor for web browsing and productivity usage, the relatively low pixel density and full screen brightness of current OLED monitors are difficult to square with the elevated costs.

For now – and very likely for a few more years to come – as surprising as it is given its many and well-documented shortcomings, LCD remains the better overall compromise for performance computing. It's remarkable, but even here in 2023 there's life yet in that clunky old LCD technology. ■

## FLAT PANEL PROGNOSTICATION WHAT'S NEXT FOR PC MONITORS?

If microLED is years away, what's in the immediate future for the PC monitor? In short, refined LCD and OLED displays. But what exactly can you expect? From a productivity perspective, one of the more exciting screens is Dell's UltraSharp U3224KB.

It's a plain old LCD monitor – it doesn't even have a mini-LED backlight. What it does have is 6,144 by 3,456 pixels or full 6K resolution. It's also a 32-inch panel, so that immediately begs comparison with Apple's Pro Display XDR, which is also a 32-inch 4K model. Could the two, in fact, be based on the same LCD panel?

It seems not. The Pro Display has a slightly different 6,016 by 3,384 pixel resolution. Anyway, the Dell screen also sports LG's IPS Black tech for improved contrast, which should clock in around 2,000:1 or about twice as good as typical IPS monitors. It's only HDR 600 certified, so it won't set new standards for brightness. But with 99 percent coverage of the DCI-P3 gamut, it promises strong colour accuracy. And boy is it going to be crispy, with over 220DPI pixel density. Yum.

On the LCD side, we're also looking forward to Samsung's latest Odyssey Neo G9. The last Neo G9 was buggy, but we can't ignore the specs of the upcoming refresh. How about an increase from 49 to 57 inches, 7,680 by 2,160 pixels and 240Hz refresh? Oh, and HDR 1000 certification. More broadly, you can expect a great many high-refresh 4K monitors in both 27-inch and 32-inch form factors, plus 1440p screens running at 300Hz and more.

One of the more exciting developments for gamers will be the AU Optronics M320QAN03.0. That's actually a bare LCD panel that monitor makers will buy in rather than a finished

display. But it promises 4K at 240Hz refresh from a 32-inch IPS form factor. It's due to go into mass production later this year, so we might just see a retail monitor with those specs by the end of 2023.

AU Optronics also has an 8K 32-inch panel with a 4,608-zone mini-LED backlight in the works for this year, which sounds like one heck of a basis for a high-end productivity screen, albeit only running at 60Hz. AU's rival BOE has a similar 5,000-zone 8K 32-inch panel on its roadmap for this year and LG also has a new 8K IPS panel planned, though for now that one is a bit of a mystery regarding further specifications. Still, it's certainly looking like 8K is going to be more widely available by the end of the year. So if you're a high-DPI aficionado, 2023 could just be the year you've been waiting for.

Speaking of 8K, believe it or not, AU Optronics actually has a 32-inch 8K OLED panel on its roadmap. Even better, it's 120Hz capable.

AU Optronics says it will have a conventional RGB subpixel structure, so it's properly optimised for the PC rather than being a TV panel reworked for PC usage. It certainly sounds like it will be the ultimate do-everything display. AU will also offer a 144Hz 4K 32-OLED option, which sounds very appealing, too, but the company hasn't revealed precise availability yet.

In the meantime, we'll see plenty more OLED monitors based on LG and Samsung TV panels. The 27-inch and 34-inch ultrawide models will all be 1440p rather than anything higher resolution, so will be essentially gaming centric rather than high-DPI and thus productivity friendly. And of course, monitors based on full 4K OLED TVs measuring 42 inches and more will become even more common, albeit they're all best suited for gaming, too. The size and pixel density isn't exactly optimal for more general desktop duties.



Dell's upcoming 6K monitor slightly beats the Apple Pro Display XDR for pixel count.





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# SPEED UP YOUR SSD

**FOR  
FREE!**

SSDs are much faster than traditional hard drives, but only if they're set up correctly. Robert Irvine reveals the best free ways to achieve and maintain your SSD's optimum speed.



## WHAT YOU CAN DO

- Check the health of your SSD and reveal its estimated lifespan
- Reduce the time it takes to save files to your SSD
- Free up space on your drive to boost its performance
- Force Windows to allocate maximum power to your SSD
- Disable unnecessary features that slow your drive
- Ensure your PC is configured to boot from your SSD
- Benchmark-test your drive to monitor its speed over time

Solid-state drives (SSDs) have revolutionised our computers over the past decade, making them faster, quieter and much more reliable. If you've bought a new laptop or desktop PC in the last few years, it almost certainly includes an SSD, either as its sole boot and storage drive, or coupled with a traditional hard disk drive (HDD) to give you extra space.

The quality and popularity of SSDs means that HDDs are being phased out. Microsoft has asked PC manufacturers to prioritise SSDs over hard drives, despite the latter being cheaper to make and buy. But although the latest SSDs are up to a hundred times faster than HDDs, they're not immune to performance problems, whether the

drive is built into your PC or you've installed it yourself.

There are many factors that can affect the speed of your solid-state drive, including incorrectly configured settings, compatibility issues and even Windows updates. Only last month, some Windows 11 users who installed the KB5023706 update experienced a massive drop in the speed of their SSDs (see [www.snipca.com/45500](http://www.snipca.com/45500)).

In this feature, we reveal how to boost the performance of your SSD by tweaking secret settings and running dedicated software. All our advice is free to try and will help your drive achieve and maintain its optimum speed.



IS YOUR SSD ABOUT TO FAIL?

Why might your SSD be about to die?

Although solid-state drives have no moving parts, which makes them faster, quieter and less prone to mechanical malfunctions than traditional hard drives, they only support a limited number of writes. This is because they use flash memory to store data rather than physical RAM, which is organised into blocks.

When data is written to unused memory on your SSD, it is locked and protected, and can't be overwritten until it's erased using an electrical charge. To update the data in a block, your SSD must copy its entire contents – including the new data – to an empty block, and then delete the original block – a process called 'garbage collection'. This means that SSDs need to perform complex operations each time they write data, which causes them to gradually wear out.

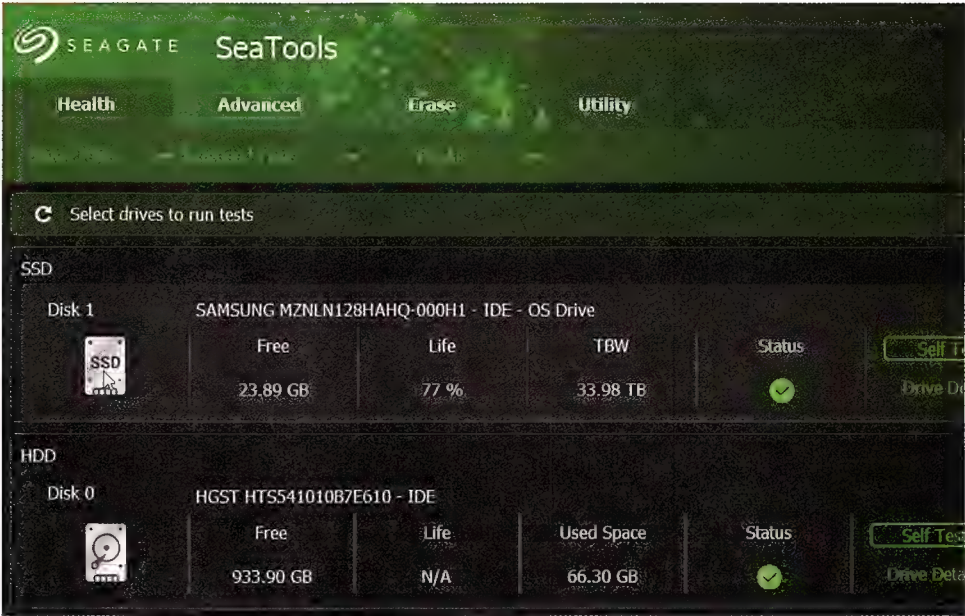
Once your drive exceeds its maximum number of writes, it will switch to 'read-only' mode and you won't be able to save or edit any more data on it – though you'll still be able to retrieve existing files.

What's the average lifespan of an SSD?

Most SSDs keep working without any problems until you've written at least 600TB of data to their memory. This means that if your drive has a 1TB capacity, and you write 200GB of data to it every day, deleting other data as you go, it should last for more than eight years (at around 73TB a year). In truth, you're unlikely to ever reach the limit, and most SSDs comfortably last for between seven and 10 years.

SSD manufacturers provide a TBW (terabytes written) figure in the product specifications – for example, 600TBW. However, this is used to define the warranty period rather than the lifespan, so it doesn't mean your device will automatically fail as soon as it's written 600TB of data or that it will even reach that amount.

The company may also quote an MTBF (mean time between failures) figure, which indicates how many hours of use you can expect from your SSD before it fails. Again, this shouldn't be taken as a guarantee it will last that long – many SSDs have an MTBF of more than one million hours or 114 years – but instead indicates the likely failure rate of an SSD over its lifetime, which means it would eventually fail if it was to last for 114 years.



Seagate SeaTools estimates your SSD's remaining lifespan based on the TBW.

How can you check your SSD's current health?

You can use the free tool CrystalDiskInfo ([www.snipca.com/45463](http://www.snipca.com/45463)) to check the current health of your SSD, including how much data you've written to it.

When you run the program, it uses SMART (Self-Monitoring, Analysis and Reporting Technology) to quickly detect and report useful information about your drive, and provide a Health Status score. In our screenshot below, CrystalDiskInfo has rated the Toshiba SSD in our almost-new Windows 11 laptop 'Good' with 99 per cent of its life remaining **1**.

We can also see that the amount of Total Host Writes is a mere 1,672GB of data **2** and that we've used our SSD for only 1,213 hours **3** – so it

should work for many more years yet (over 100, hypothetically) before reaching its data-writing limit.

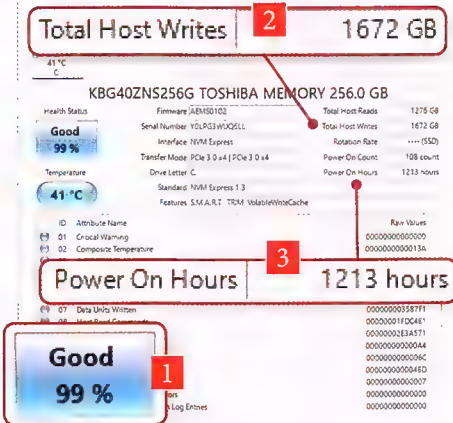
If CrystalDiskInfo is unable to detect this information, or you want a second opinion, download Seagate's SeaTools software from ([www.snipca.com/45464](http://www.snipca.com/45464)). This works with all makes of SSD and gives you both a lifespan estimate and a TBW figure. In our screenshot above, SeaTools states that the Samsung SSD in our older Windows 10 laptop has 77 per cent of its life remaining after we've written nearly 34TB of data to the drive.

If your SSD is healthy, why is it slow?

Even if your SSD has lots of data-writing cycles – and therefore years – to go, many other factors can adversely affect its performance. As it fills up with files and programs, it will start running out of empty blocks, which means it will take longer to write data – a drive that's at 80-per-cent capacity will be noticeably slow.

There may also be problems with how your SSD interacts with Windows and the rest of your PC, such as outdated drivers, incorrect settings and mismatched hardware, or 'bad blocks' that prevent you from writing data.

Thankfully, as we explain over the following pages, there are several free ways to optimise your SSD's performance that save you having to pay to upgrade your drive.



CrystalDiskInfo reveals your SSD's health status and how much data it's written.



## TWEAK WINDOWS TO BOOST YOUR SSD SPEED

### Check and enable your the Trim command

As we explained on the previous page, your SSD needs to move data and delete blocks before it can write new information to its memory – a process that requires both time and power. To speed up the operation, Windows PCs offer a command called Trim (sometimes capitalised as TRIM, though it's not an acronym), which tells your SSD which blocks of data are no longer in use and can be safely erased. This means that when you save new data to the drive, your SSD doesn't need to waste time moving and deleting data to make room for it, so the writing process is as fast as possible.

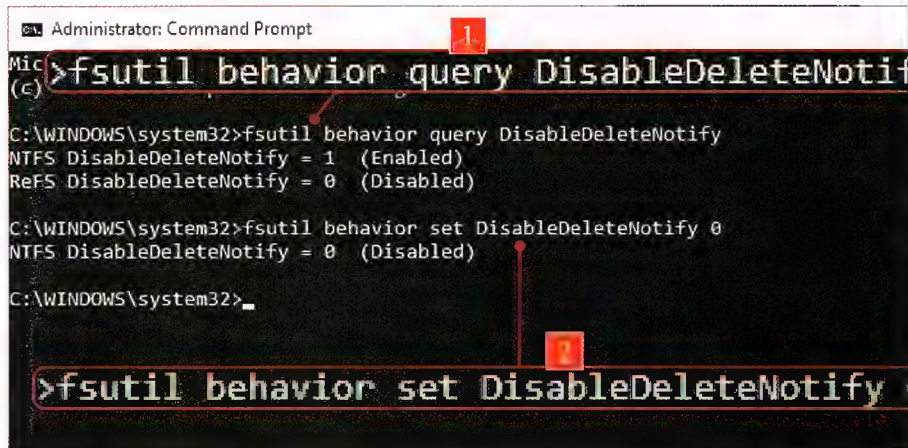
Windows 10 and 11 should detect and enable Trim automatically, but it's worth double-checking, especially if your SSD is running slowly. Type cmd into the taskbar search box, choose 'Run as administrator' under Command Prompt and click Yes to allow changes to your PC. When Command Prompt opens, type the following command and press Enter: `fsutil behavior query DisableDeleteNotify` (■ in our screenshot above right, top) – you can copy this from Pastebin at [www.snipca.com/45465](http://www.snipca.com/45465).

If the command gives you the result 'DisableDeleteNotify = 0', then Trim is enabled, and no further action is required. This detail will appear next to your SSD's file-system type, such as NTFS – Windows 11 makes clear that it means 'Allows TRIM operations to be sent to the storage device'. But if you get a result of 'DisableDeleteNotify = 1', then Trim isn't running and your SSD isn't receiving the necessary information from Windows.

To turn on Trim, type the following command and press Enter: `fsutil behavior set DisableDeleteNotify 0` (■ – you can copy this from Pastebin at [www.snipca.com/45466](http://www.snipca.com/45466)). After running the command, you'll see the result 'DisableDeleteNotify = 0', which confirms that Trim is now active. Confusingly, this is a double-negative that tells you the option to disable the feature is itself disabled.

### Turn off Hibernation to speed up your SSD

SSDs have smaller capacities than similarly priced mechanical hard drives, and slow down as they fill up, so it's important to get rid of junk

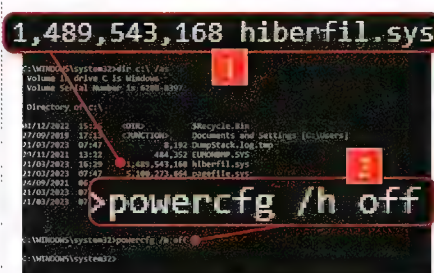


```
Administrator: Command Prompt
C:\WINDOWS\system32>fsutil behavior query DisableDeleteNotify
NTFS DisableDeleteNotify = 1 (Enabled)
ReFS DisableDeleteNotify = 0 (Disabled)

C:\WINDOWS\system32>fsutil behavior set DisableDeleteNotify 0
NTFS DisableDeleteNotify = 0 (Disabled)

C:\WINDOWS\system32>_
>fsutil behavior set DisableDeleteNotify 0
```

Ensure Trim is enabled to write data to your SSD as quickly as possible using these commands.



```
C:\WINDOWS\system32>cmd /c fsutil behavior query DisableDeleteNotify
1,489,543,168 hiberfil.sys
C:\WINDOWS\system32>powercfg /h off
```

Reclaim space and boost your SSD's speed by disabling the Hibernation feature.

files you don't need.

One of the biggest space hogs is the Hibernation feature, which is designed to conserve power when you're not using your PC. It works by copying everything in your system's memory to a file called 'Hiberfil.sys', then powering down your computer. When you turn it back on, Windows loads all the data from the saved file.

However, because SSDs use less power than standard hard drives, they don't require hibernation, and copying data to the 'Hiberfil.sys' file simply wastes valuable space and slows things down. This is especially true when you're using a mains-connected PC rather than a laptop running on a battery.

To discover how much space Hibernation uses, run Command Prompt as an administrator then type the following command and press Enter: `dir c:\ /as` (replace 'c:\' with your SSD's drive letter if different). Look at the figure for 'hiberfil.sys' to see how much storage the file wastes – nearly 1.5GB on our PC (see ■ in our screenshot above).

To disable the Hibernation feature and speed up your SSD, type `powercfg /h off` into Command Prompt (■ and press

Enter. You won't receive confirmation that Hibernation is disabled, but you can check by typing `powercfg /a` and pressing Enter – this should display a response that 'Hibernation has not been enabled'. Turn 'Hibernation' back on again by entering the command `powercfg /h on`.

### Ensure that write-caching is enabled

SSDs use a feature called write-caching to temporarily store data in their memory before it's permanently saved to a block. This allows them to perform operations more quickly, though it means there's a small risk of losing data if there's a power cut.

Write-caching should be enabled by default in Windows 10 and 11, but it's worth checking to ensure your SSD is working at optimum speed. Type device manager into the search box, choose Open next to Device Manager and click the arrow next to 'Disk drives'. Right-click the name of your SSD, choose Properties and on the Policies tab make sure the option 'Enable write caching on the device' is ticked (see screenshot below).

SAMSUNG MZNLN128HAHQ-000H1 Properties

General Policies Volumes Driver Details Events

Write-caching policy

☒ Enable write caching on the device

Improves system performance by enabling write caching on the device, but a power outage or equipment failure might result in data loss or corruption.

☐ Turn off Windows write-cache buffer flushing on the device

☒ Enable write caching on the device

Keep your SSD working smoothly by enabling write-caching.



Switch to a high-performance power plan

Although SSDs use less electricity than traditional hard drives, and are therefore cheaper to run, it's still possible that Windows isn't allocating enough power to your drive. This will prolong battery life when you're out and about, but at home you can tweak your power settings to boost your SSD's speed.

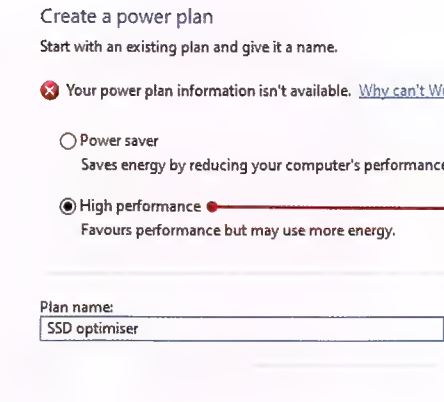
In Windows 10, open Settings and select System, then 'Power & sleep' and choose 'Additional power settings'. Click 'Create a power plan' and select 'High performance' (see screenshot above right) to allow your SSD to run at full capacity. Click 'Next' and specify whether the new settings apply only when your computer is plugged in, or on battery as well, then click Create.

You can also prevent your SSD from switching off when idle, to save you waiting a second or two for it to 'wake up', though this will mean it uses more power. Click 'Change advanced power settings' and open 'Hard disk' then 'Turn off hard disk after'. Choose 'Never' next to 'Plugged in' and click Apply or OK.

In Windows 11, open Settings and click System, then 'Power & battery' and select 'Best performance' in the 'Power mode' menu.

Turn off search indexing in Windows

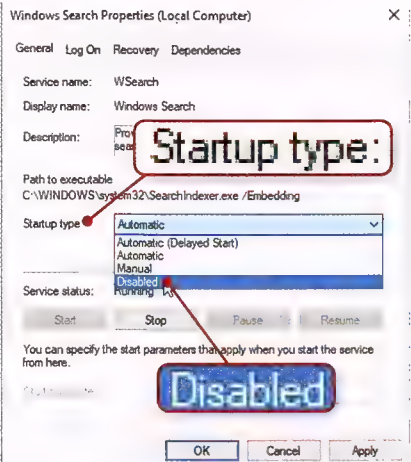
Windows includes a tool called Search Indexer, which runs constantly in the background. It catalogues the files and folders on your drives, so you can find them quickly when carrying out a search, but it also uses a fair amount of processing power and memory. Your SSD is fast enough to find the files without referring to a search index,



Change your power plan to optimise your SSD for the highest possible performance level.

which means the feature just slows it down.

To disable search indexing in Windows 10 or 11 (and stop it diverting system resources from your SSD) type services into the search box and open the Services app. Scroll down to Windows Search and double-click it to



Your SSD can find files quickly without requiring the Windows Search Indexer.

open its Properties box. Click the Stop button to terminate the Search Indexer process, then choose Disabled in the 'Startup type' dropdown menu (see screenshot below left).

Click 'Apply' or OK to turn off search indexing. You can turn it back on again by choosing Automatic in the 'Startup type' menu and clicking Start.

Update your SSD's drivers

Windows should automatically update your SSD's drivers through Windows Update, to keep it running smoothly and fix performance bugs (though sometimes it has the opposite effect). But you can also check for updates manually, rather than wait for Windows to install them.

Right-click your SSD in the 'Disk drives' section of Device Manager and choose 'Update driver'. Click 'Search automatically for drivers' to check for updates and Windows will check for recent updates. If it doesn't find any, click 'Search for updated drivers on Windows Update' then choose 'Check for updates' to give it a nudge.

SHOULD YOU DEFRAGMENT YOUR SSD?

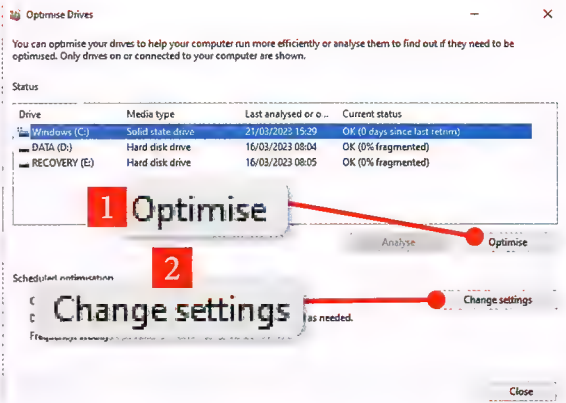
Defragmenting a hard drive reorders its contents so that data is arranged into adjoining sections, but this isn't necessary with a solid-state drive. Because an SSD uses flash memory rather than mechanical parts, it's able to read scattered blocks of data almost as quickly as it can read adjacent blocks, so there's no speed benefit to moving data around. Defragging an SSD using a dedicated program can actually shorten its lifespan by performing unnecessary writes.

Windows recognises that your SSD doesn't need traditional defragmenting, and instead 'optimises' the drive through its 'Defragment and Optimise Drives' tool. This optimisation process uses the Trim command to detect which areas of your drive should be considered empty and are ready to write new data to.

By default, Windows 10 and 11 optimise

– or 'retrim' – your SSD on a weekly schedule, but you can also perform the task manually to address speed problems or change the frequency to monthly if you're worried about wearing out your drive.

Type defrag into the search box, select 'Defragment and Optimise Drives' and choose your SSD. Click the Optimise button (1 in our screenshot) to retrim your drive immediately – this is much faster than standard defragging. Alternatively, click 'Change settings' 2, select Monthly in the 'Run on a schedule' menu and click OK.





## SPEED UP AN SSD YOU INSTALL YOURSELF

### Set your PC to boot from your SSD

If your computer came with an SSD installed, it should be configured to boot from that drive before any other hard drives, so that Windows starts in seconds. But if you've added an SSD yourself, you need to make sure it's set as the priority boot device or your PC will start much more slowly.

To change the boot order, you need to access your PC's UEFI or BIOS. In Windows 10, open Settings, click 'Update & Security', then Recovery and click the 'Restart now' button in the 'Advanced start-up' section. In Windows 11, choose System, then Recovery and click 'Restart now'.

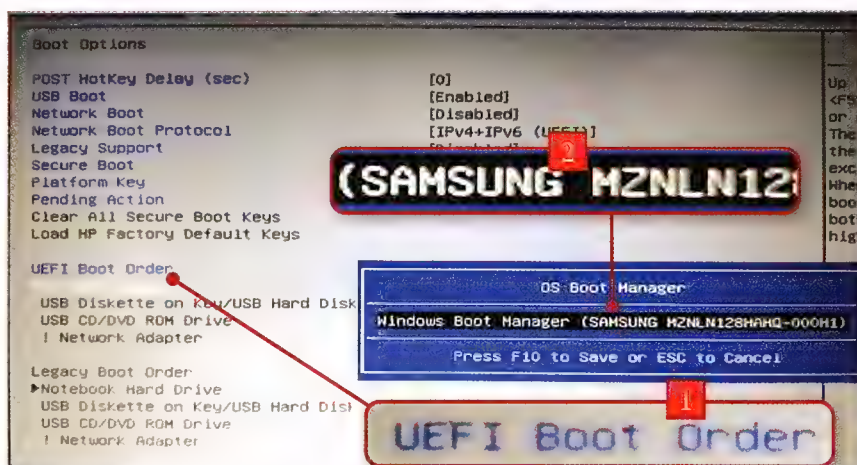
Once your PC restarts, choose Troubleshoot, then 'Advanced options', select UEFI Firmware Settings and click Restart. On the UEFI or BIOS screen that opens, choose Boot Options (or similar) and select the option called Boot Order (1 in our screenshot above right), Boot Sequence or Boot Priority. Use the specified keys on your keyboard or the options in the on-screen menu to configure the boot order so your SSD appears first (as we've done with our Samsung drive 2).

If your SSD isn't listed, you may need to open your PC's case and disconnect your old hard drive from your motherboard, so your UEFI or BIOS automatically detects the new drive.

Save the new boot order, exit the UEFI or BIOS screen and restart your PC again. Your SSD will now start your computer significantly faster than before.

### Check how your SSD connects to your PC

The simplest way to add an SSD to your computer is to buy an external drive that connects via a USB cable, but you'll get faster speeds from a device that slots into your PC's motherboard – we look at the best new options for both



Set your SSD as the first boot device to start your PC as quickly as possible.

types on page 80. Whichever SSD you choose, it's essential to ensure it plugs into the right port using the correct cable, or you won't get the performance you paid for.

If you're planning to replace your internal hard drive with an SSD, you'll almost certainly need a device with a SATA (Serial Advanced Technology Attachment) interface. Unless you have a particularly old PC, this is likely to be SATA III, which offers a maximum data-transfer rate of 6 gigabits per second (Gbps) – with eight bits to a byte, this means a write speed of 750 megabytes per second (MB/s).

You connect your SSD to your PC's SATA power supply using the 15-pin power cable and to your motherboard using the seven-pin data cable (see photo below of a Samsung SATA SSD). Use the first (lowest numbered) SATA port on your motherboard to set your SSD as the default boot drive and ensure a speedy start-up.

Things get more complicated when upgrading an existing SSD, because it could have a PCIe or M.2 interface, and use a newer connection standard called NVMe, which is at least five times as fast as SATA. These devices

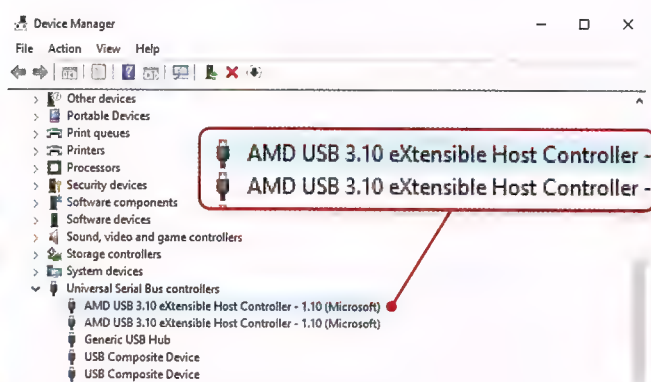
have different fittings to SATA SSDs, so to avoid frustration, make sure to check your PC's specifications before you buy a new solid-state drive.

Plugging an external device into a USB port is a lot easier than fiddling around inside your PC, but for optimum performance your computer will need to use the same USB standard as the SSD. Many new drives are USB 3.2 Gen 2, which can transfer data at up to 10Gbps (1250MB/s) – theoretically faster than internal SATA drives. But if you only have USB 3.0 ports, your SSD will be less than half as fast at up to 4.8Gbps (600MB/s), because the speed depends on the slowest link in the chain. A USB 2.0 port on a much older PC will cut your data-transfer rate to a sluggish 480Mbps (60MB/s).

You can check the USB version of your ports by opening the USB Serial Bus Controllers section in Device Manager. In our screenshot below, we can see that our laptop has two USB 3.10 'host controllers', which means its ports will get the optimum speed from USB 3.0 and 3.1 (Gen 1) SSDs (which, confusingly, are the same standard).



A SATA SSD connects to your PC using a power cable and a data cable.



Our PC has USB 3.1 ports so will get optimum speed from USB 3.0 SSDs.



TEST & COMPARE THE SPEED OF YOUR SSD

Before – and after – you tweak your SSD’s settings to boost its performance, it’s useful to get accurate information about its read and write speeds.

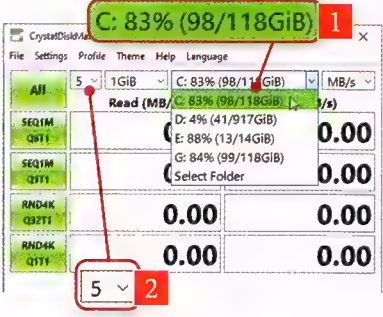
After all, reliable data about how efficiently your drive is able to perform everyday tasks is a much better means of assessment than a

vague impression that it ‘seems to be a bit slow’.

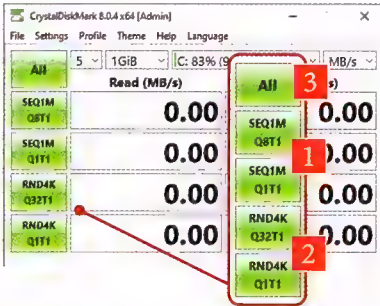
You can benchmark your SSD using the brilliant free tool CrystalDiskMark ([www.snipca.com/45481](http://www.snipca.com/45481)). This provides quick but thorough tests of SSDs (and traditional hard drives), and presents its results in a clear, concise manner.

The developer warns that “CrystalDiskMark may shorten SSD life”, but this is only a problem if it’s used excessively – running the tool once a month is enough to gauge your drive’s performance without wearing it out. Below we show how to use CrystalDiskMark.

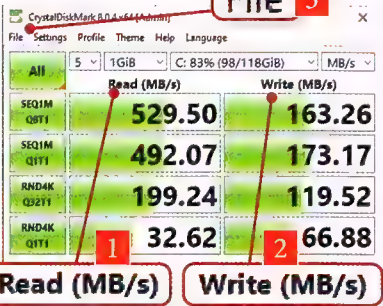
**01** Download the Standard Edition of CrystalDiskMark from [www.snipca.com/45483](http://www.snipca.com/45483) – click the green Installer button below the screenshot on the website and watch out for the deceptive ads on the page. Install and launch the program, and select your SSD in the dropdown drive menu **1**. You can also change the number of times the program performs each test – the default is five **2**, which produces the most accurate results, but decreasing the number will save you time.



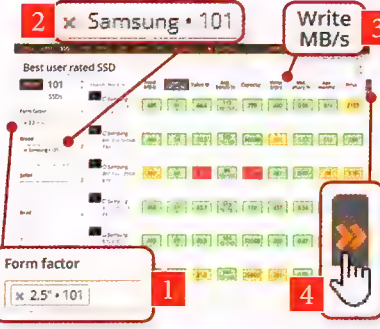
**02** CrystalDiskMark runs four tests, split into ‘read’ (where data is copied from your SSD) and ‘write’ (data copied to your SSD). The first two tests **1** use sequential data that’s stored in adjacent blocks, while the second two **2** use data that’s spread out randomly across your SSD. Once you’re familiar with the program, you can run these tests individually to get specific information, but for an initial performance overview, click the All button **3**.



**03** The tests take a few minutes to complete, depending on the size of your SSD. Our results show our drive’s read speeds **1** are considerably faster than its write speeds **2** except for the final random test – the first sequential Write result is the most important. This difference is normal for a SATA SSD like ours, though it suggests there’s potential to speed up our drive. To save the information to compare it with results from future tests, click the File menu **3** and choose ‘Save (text)’.



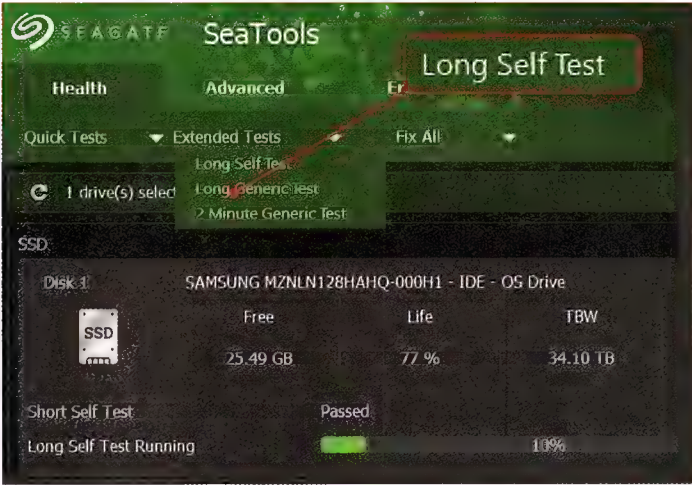
**04** To see how your SSD’s speed compares with other users, go to [www.snipca.com/45488](http://www.snipca.com/45488). Click the ‘Form factor’ box **1** and choose your SSD type – 2.5” covers most SATA devices – then the Brand box **2**, and select the manufacturer **2**, and look for your SSD model or one with similar specs. Compare the result from your first write-speed test with the figure in the ‘Write MB/s’ column **3**. To also compare read-speed results, click the ‘Add columns’ button **4** and choose Read.



FIX BAD BLOCKS ON YOUR SSD

If your SSD seems abnormally slow, and this is borne out by the benchmark test, it could be suffering from ‘bad blocks’. These are caused by memory corruption or physical damage, and slow down your drive as it tries to read or write data, before ultimately failing and displaying an error message. Unfortunately, you can’t usually recover data from bad blocks, though you may be able to repair the blocks to stop them affecting your

SSD’s performance, using Seagate SeaTools ([www.snipca.com/45464](http://www.snipca.com/45464)). Close other programs, then launch SeaTools and select your drive. Click the Extended Tests button, choose Long Self Test (see screenshot) then click ‘OK’. SeaTools will then scan your SSD to detect any bad blocks and display its results. If it finds any, it will offer to repair them, but you should back up any important files first.





## BEST SSDS YOU CAN BUY NOW



### BEST FOR SPEED

#### Corsair MP600 Pro LPX

From \$114 from [www.snipca.com/41547](http://www.snipca.com/41547)

Our top performance choice for SSDs requires an M.2 slot on your motherboard and is compatible with the latest PCIe 4.0 standard, so it will work best with PCs bought in the last few years. It's available in various capacities, with the cheapest model (500GB) recently reduced to \$114 while the 1TB version now costs only \$157. In our tests, the Corsair MP600 Pro LPX was blazingly fast, delivering a sequential read speed of 7,364MB/s and a write speed of 6,870MB/s. This makes the drive ideal for huge file transfers and to use as your main boot drive.



### BEST FOR VALUE

#### WD Blue SN570

From \$47 from [www.snipca.com/45495](http://www.snipca.com/45495)

Although this M.2 SSD from Western Digital uses PCIe 3.0 rather than the newer 4.0 standard, it's still significantly faster than SATA and USB drives, and offers incredible value for money. Its read and write speeds of 2,400 MB/s and 1,950 MB/s respectively are certainly not to be sniffed at and you can choose the capacity that best suits your storage needs. The 250GB model currently costs less than \$50 on Amazon, and even the 1TB drive is only \$94.



### BEST FOR CAPACITY

#### Sabrent Rocket 4 Plus

From \$159 from [www.snipca.com/45498](http://www.snipca.com/45498)

If you want as much storage as possible, and money is no object, you can now buy multi-terabyte drives to set you up for life. The Sabrent Rocket 4 Plus may be tiny (and rather fancy in design) but its maximum capacity is 8TB. That size will set you back over \$700, but the steep price is justified by its impressive read and write speeds of 7,000MB/s and 5,300MB/s via PCIe 4.0. If you can make do with half that space, the 4TB model (pictured) costs less than half the price and offers the same amazing speeds. There are also 500GB, 1TB and 2TB versions.



### BEST FOR PORTABILITY

#### Samsung T7 Portable

From \$108 from

[www.snipca.com/45493](http://www.snipca.com/45493)

Available in grey, blue or red, and in sizes ranging from 500GB to 2TB, the Samsung T7 Portable packs a lot of storage into a compact, colourful and lightweight (58g) device. It uses USB 3.2 Gen 2, which enables it to deliver read and write speeds of 1,000MB/s, and comes with USB-A and USB-C cables to quickly connect it to any PC. The SSD can be protected using AES 256-bit encryption, which means it's both secure and fast. If you're the clumsy type, there's also a pricier T7 Shield version, which is encased in rubber to protect it against knocks and drops.



### BEST FOR OLDER PCs

#### Crucial MX500

From \$38 from

[www.snipca.com/45497](http://www.snipca.com/45497)

As the price of slimline M.2 SSDs comes down, the cost of SATA-powered 2.5in drives has gone up, due to the cost of manufacturing them. However, if you want to fit an internal SSD into an older PC, there are still some great bargains around, and this Crucial drive is arguably the best. Its read and write speeds are only 560MB/s and 510MB/s respectively, but this is to be expected from a SATA device and is still much faster than a mechanical hard drive. What's more, it's reliable, affordable (the 1TB model costs only \$97) and comes with a five-year warranty. ■

## WHAT TO LOOK FOR IN AN SSD

### KNOW YOUR COMPUTER

Check that your motherboard has slots for M.2 drives and that your PC supports NVMe/PCIe. If so, you can buy a drive that will offer excellent speeds. If not, you may need to buy a 2.5in SATA drive, which will be slower but will at least be compatible with your PC and still manage everyday tasks.

### BUY THE RIGHT CAPACITY

Don't buy a drive that has less than 250GB of storage. 500GB offers a good balance between price and capacity, but as many 1TB drives now cost less than \$100, they're increasingly good value, and ensure you won't run out of space.

### DON'T BUY A HARD DRIVE

Any SSD is better than a mechanical hard drive, and at least three times as fast. With prices so cheap these days, there's no excuse for falling back on an HDD.



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PC BUILDER

## System News

Mark Williams looks at why last-gen specs are still good enough.



**Mark Williams**  
Mark is an IT professional with a strong interest in voiding warranties.

New PC prices are still historically quite high. After the crypto boom caused graphics card prices to go stratospheric, and the COVID pandemic simultaneously causing supply constraints and high demand for computer parts, we're still feeling the after effects of it all, while rising inflation and increasing costs of the latest manufacturing nodes isn't helping. As a result, a new PC with the latest parts now costs much more than what they traditionally have. While GPU prices have come down substantially from the peak, they've settled down at a comparatively elevated level relative to pre-2020 prices. Effectively pushing each GPU up a tier in pricing.

To combat this, a new trend of continuing to offer previous-generation parts – or even two generation old parts in “new” systems – has gained traction to lower overall system costs. Typically, last generation

motherboards and processors would be phased out after a few months of the new ones arriving, but today there are still plenty of budget systems being offered with one or two generation old parts in them.

AMD has had a particularly bad time with platform affordability as its new AM5 socket ushered in mandatory costly PCIe 5.0 and DDR5 support. Whilst AMD's base B650 chipset doesn't mandate PCIe 5.0 support, the cheapest B650 boards with only PCIe 4.0 support still cost at least \$300. Coming from lows of \$100-\$150 for previous B450 and B550 boards, this is a huge increase.

AMD recently announced the A620 chipset which will help drive down AM5's platform costs. The primary differentiators are that while B650 can optionally have PCIe 5.0 support (depending on the manufacturer's choices), A620 only supports PCIe 4.0, which isn't so bad given that the fastest GPUs

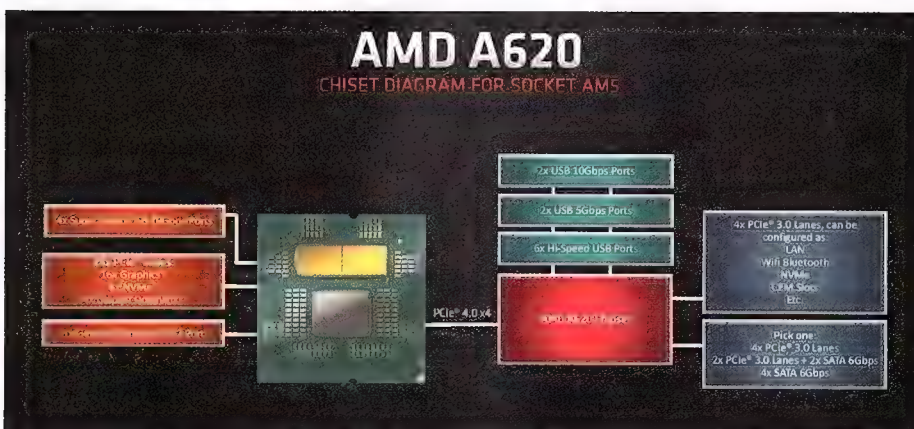
are still only using PCIe 4.0 and PCIe 5.0 SSDs are only just beginning to appear, and at a high price.

A620 doesn't support CPU overclocking and officially only supports 65W CPUs (so non-X variants) although manufacturers can up that to support X series CPUs as well, at additional cost using beefier VRMs. A620 does still support memory overclocking, so RAM kits with EXPO timings will still work.

Apart from that, the A620 is much like the previous generation B550 in terms of connectivity with the same amount and speed USB ports (2x USB 10Gbps, 2x 5Gbps and 6x 480Mbps) but loses two PCIe 3.0 lanes from the chipset for eight total compared to B550's ten. However, Ryzen 7000 CPUs pick up the slack here by offering an extra four lanes of PCIe 4.0 from the CPU for twenty-four total, allowing for dual M.2 NVMe drives along with a full 16x width PEG slot.

A620-based motherboards should start arriving on shelves and in systems soon, and with a quoted starting price of USD\$85 we should see motherboards coming in well below AUD\$200, hopefully more around AUD\$150.

These specifications, while not leading edge, are still very decent for gaming builds today. Even well into higher end configurations, the trick will be determining which models have strong enough VRM capabilities. They'll cost a little more but will be a very cost-effective way into the AM5 ecosystem. ■





# Market Watch

A sampling of PC systems available this month.



## IJK SUPERIOR GAMING PC

\$2,801 | [tinyurl.com/APCC520-IJK](https://tinyurl.com/APCC520-IJK)

It wasn't that long ago that an RTX 3090 cost more than this PC. Now the RTX 4070 Ti can beat it and you also get the rest of the PC too!

The rest of the system is decidedly last-gen with the budget conscious R5 5600X sitting in a B550 motherboard, certainly capable enough for the GPU if you keep game settings on the quality end to keep the GPU loaded as it might otherwise hold back performance, especially with the 3200MHz RAM. The SSD is also last gen being PCIe 3.0, but you are also getting 1TB of secondary SSD space so it's hard to complain at this price. A good value system.

**CPU:** AMD Ryzen 5 5600X; **Cooler:** Cooler Master MasterLiquid ML240L V2 ARGB; **Motherboard:** Asus Prime B550M-A WIFI II; **Graphics:** Gigabyte GeForce RTX 4070 Ti Eagle OC 12GB; **Memory:** 16GB Corsair Vengeance RGB PRO DDR4 3200MHz C16; **Storage:** Kingston SNVS 500GB M.2 SSD, Crucial BX500 1TB SATA SSD; **Power Supply:** Corsair RM850e 850W; **Case:** DeepCool Matrexx50.



## BPC TECHNOLOGY KRAKEN POWER AIR BLADE

\$1,439 | [tinyurl.com/APC520-BPC](https://tinyurl.com/APC520-BPC)

BPC is selling this system for just \$500 over the price of the graphics card, this system is cheap! A little too cheap.

Sure, you get the new and powerful RTX 4070, but it seems to be at the cost of everything else.

While the CPU isn't too bad, everything it's connected to is lacking. The three generation old motherboard only supports PCIe 3.0, meaning GPU performance will be hamstrung. The single 8GB stick of RAM is not only lacklustre in capacity, the missing second DIMM means the CPU is running in single-channel mode, losing yet more performance.

Oh, and Windows is not included. Think very carefully before considering this PC.

**CPU:** AMD Ryzen 5 5600; **Cooler:** OEM; **Motherboard:** Asus TUF Gaming B450M-PRO II; **Graphics:** MSI GeForce RTX 4070 Ventus 2X 12G OC; **Memory:** Adata 8GB (1x8GB) AD4U32008G22-SGN 3200MHz DIMM DDR4 RAM; **Storage:** Western Digital Green 480GB M.2 NVMe SSD; **Power Supply:** EVGA 700 GQ 700W; **Case:** Gamdias Talos E3 Mesh.



## AFTERSHOCK PC CHAMBER: LVL 9 ULTRA

\$5,500 | [tinyurl.com/APC520-AFT](https://tinyurl.com/APC520-AFT)

This showy PC is built inside the Hyte Y40 case to maximise the visuals of its internals, which are well picked to match a white and black theme. With the powerful RTX 4080 on display, the CPU also gets lots of love with a white 360mm AIO water cooler.

32GB of RAM is good to see and a 1200W PSU is also very welcome, offering great future proofing for upgrades.

The 2TB SSD is also perfect. This may cost a lot of money, but it equally also offers a lot of well-balanced and placed performance. A great build for high-end gamers.

**CPU:** Intel Core i7 13700KF; **Cooler:** Aftershock Glacier Mirror 360mm (White); **Motherboard:** Gigabyte Z790 Aorus Elite AX; **Graphics:** Zotac RTX 4080 AMP Extreme Airo (White Edition) 16GB; **Memory:** 32GB ADATA Lancer RGB White DDR5 6000MHz; **Storage:** 2TB Gen4 Samsung M.2 NVMe SSD; **Power Supply:** FSP Hydro Ptm Pro 1200W **Case:** Hyte Y40 - White.

## THERMALTAKE RAPTURE XTREME V4

\$5,999 | [tinyurl.com/APC520-TT](https://tinyurl.com/APC520-TT)

Going up against Aftershock's Chamber system, this equally capable PC has a few differences. The primary one being the AMD Ryzen 9 7900X CPU giving this generally slightly better productivity capabilities depending on the task, while also drawing less power and thus generating less heat. 32GB is a good amount of RAM but the 5600MHz speed is a little below what Ryzen 7000 CPUs ideally like. Mass storage is split between a 1TB SSD and 4TB HDD. So, over double the storage relative to the Aftershock system, though with half the SSD capacity. A good system for productivity use where gaming is also a priority.

**CPU:** AMD Ryzen 9 7900X; **Cooler:** Thermaltake Floe Ultra 360 AIO; **Motherboard:** AM5 X670 chipset based (with WIFI); **Graphics:** GeForce RTX 4080 16GB; **Memory:** 32GB Thermaltake ToughRAM XG RGB DDR5 5600MHz; **Storage:** Samsung 980 PRO 1TB M.2 NVMe SSD, Seagate 4TB HDD; **Power Supply:** Thermaltake Toughpower GF3 1000W; **Case:** Thermaltake Core P6.





# Blueprints

Value- and performance-driven hypothetical builds

## BUDGET

*A perfect balance between price and performance.*

After completing a budget Intel build recently, we thought we'd take a few things from that personal project to bring costs down further across both our Blueprint Budget machines. First things first, we decided to upgrade our Intel i3-12100 to a newer Intel Core i3-13100F. Yes, it being an F model means it requires a GPU. However, because we are adding one, we can save a few dollars on the CPU. Also, this 13th gen i3-13100F is cheaper than the previous i3-12100, so for this system, it's a no-brainer. It will more than likely require a BIOS update on our motherboard, though. This may require you to have an older CPU to boot it up into the BIOS, so always bear that in mind when upgrading to the next-gen CPU, even if it states it's compatible.

The other change to the Intel budget machine was to bring in the Intel Arc A750 to replace the Asus TUF Gaming EVO OC GeForce GTX 1660 Ti 6GB GPU. The Intel card is newer, cheaper, and has faster GPU and clock speeds, and we experienced comfortable 1080p gaming. Other than the CPU/GPU changes, the build remained the same.

We also made a CPU change on the AMD rig due to the ending of a sale on our AMD Ryzen 5600X. We decided to opt for the non 'X' variant, the standard 5600, as this is near



enough identical in specs. The difference is it just has a slightly slower base frequency (3.5GHz compared to 3.7GHz) and a slightly slower max boost clock (4.4GHz compared to 4.6GHz). That was the only change we made, and with a slight SSD price decline, our AMD budget build went from \$1,249 to \$1,132.

## AMD INGREDIENTS

| Part  |                                                         | Price   |
|-------|---------------------------------------------------------|---------|
| Case  | Corsair 4000D Airflow                                   | \$169   |
| PSU   | Thermaltake Litepower Gen2 450W                         | \$59    |
| Mobo  | MSI B550M PRO-VDH WIFI Micro ATX AM4 Motherboard        | \$179   |
| CPU   | AMD Ryzen 5 5600 <b>NEW</b>                             | \$209   |
| GPU   | MSI Mech 2X OC Radeon RX 6500 XT 4GB                    | \$239   |
| RAM   | 16GB (2x 8GB) PNY XLR8 Gaming Epic-X RGB DDR4 @ 3200MHz | \$89    |
| SSD   | 500GB PNY CS2140 PCIe 4.0 M.2 SSD                       | \$59    |
| HDD   | 2TB Seagate Barracuda Compute 7200                      | \$69    |
| OS    | Windows 10 Home 64-bit OEM (Windows 11 Compatible)      | \$60    |
| Total |                                                         | \$1,132 |

## INTEL INGREDIENTS

| Part  |                                                         | Price   |
|-------|---------------------------------------------------------|---------|
| Case  | Corsair 4000D Airflow                                   | \$169   |
| PSU   | Thermaltake Litepower Gen2 450W                         | \$59    |
| Mobo  | Asrock B660M-HDV Micro ATX LGA1700                      | \$159   |
| CPU   | Intel Core i3-13100F <b>NEW</b>                         | \$189   |
| GPU   | Intel Limited Edition Arc A750 8GB <b>NEW</b>           | \$389   |
| RAM   | 16GB (2x 8GB) PNY XLR8 Gaming Epic-X RGB DDR4 @ 3200MHz | \$89    |
| SSD   | 500GB PNY CS2140 PCIe 4.0 M.2 SSD                       | \$59    |
| HDD   | 2TB Seagate Barracuda Compute 7200                      | \$69    |
| OS    | Windows 10 Home 64-bit OEM (Windows 11 Compatible)      | \$60    |
| Total |                                                         | \$1,242 |





"You can pick up the 12600KF for \$409, so if you have a dedicated GPU, it makes sense to save some money and go for the 'F' variant."

MID-RANGE

A game-ready machine that can also handle demanding work.

With more virtual money, our mid-range builds have larger scope for faster components, but that's not to say we don't want to keep costs down. So to save money, we did exactly what we did on the AMD budget machine and applied it here. We substituted the AMD Ryzen 7 7600X for the Ryzen 7 7600. They both share the same six Zen 4 cores and 38MB of cache – it's just that the non 'X' variant has a lower 3.8GHz base clock compared to the 7 7600X, at 4.7GHz. Also, the 7 7600's max boost clock is 0.2GHz slower at 5.1GHz.

Plus, with some slight automatic overclocking using AMD's Precision

Boost Overdrive (PBO) through the AMD Ryzen Master Utility app, you can get the Ryzen 7 7600 up to similar performance figures as the Ryzen 7600X. The Ryzen 7 7600 also comes with an AMD Wraith Stealth cooler, unlike its more expensive sibling. This was the only change we made this time for the AMD mid-range build, resulting in a total price of \$2,295. That's \$74 less than the last, but it would have been more if we hadn't changed the CPU.

On the mid-range Intel build, price differences forced us to change components here, too. Last issue, our GPU, the Asus GeForce RTX 3060 Ti

TUF Gaming OC 8GB, cost \$729, but thanks to the Gigabyte GeForce RTX 3060 Ti Eagle OC 8GB coming back in stock, we've opted for this, as it's \$699 and offers similar performance. We also chose the Intel Core i5-12600KF over the previous i5-12600K to save money, as we don't need the Intel integrated UHD Graphics 770 thanks to our 3060 Ti. You can pick up the 12600KF for \$409, so if you have a dedicated GPU, it makes sense to save some money and go for the 'F' variant. Overall, the price is now \$111 lower while delivering the same performance.

AMD INGREDIENTS

| Part   |                                                      | Price   |
|--------|------------------------------------------------------|---------|
| Case   | Nzxt H7 Flow                                         | \$259   |
| PSU    | 750W EVGA 750 BP 80+ Bronze                          | \$109   |
| Mobo   | Asrock B650M PG Riptide WIFI Micro ATX AM5           | \$349   |
| CPU    | AMD Ryzen 5 7600 <b>NEW</b>                          | \$349   |
| Cooler | Cooler Master Masterliquid ML240L RGB V2             | \$109   |
| GPU    | Gigabyte Radeon RX 6750 XT Gaming OC 12GB            | \$639   |
| RAM    | 32GB (2x 16GB) Corsair Vengeance DDR5 CL40 @ 4800MHz | \$220   |
| SSD    | 1TB Crucial P5 Plus NVME M.2 PCIe 4.0                | \$129   |
| HDD    | 2TB Seagate Barracuda Compute 7200                   | \$69    |
| OS     | Windows 10 Home 64-bit OEM (Windows 11 Compatible)   | \$60    |
| Total  |                                                      | \$2,295 |

INTEL INGREDIENTS

| Part   |                                                      | Price   |
|--------|------------------------------------------------------|---------|
| Case   | Nzxt H7 Flow                                         | \$259   |
| PSU    | 750W EVGA 750 BP 80+ Bronze                          | \$109   |
| Mobo   | Gigabyte Z790 UD AC ATX LGA 1700                     | \$379   |
| CPU    | Intel Core i5-12600KF <b>NEW</b>                     | \$409   |
| Cooler | Cooler Master Masterliquid ML240L RGB V2             | \$109   |
| GPU    | Gigabyte GeForce RTX 3060 Ti Eagle OC 8GB <b>NEW</b> | \$699   |
| RAM    | 32GB (2x 16GB) Corsair Vengeance DDR5 CL40 @ 4800MHz | \$220   |
| SSD    | 1TB Corsair MP600 PRO NH M.2 PCIe 4.0                | \$129   |
| HDD    | 2TB Seagate Barracuda Compute 7200                   | \$69    |
| OS     | Windows 10 Home 64-bit OEM (Windows 11 Compatible)   | \$60    |
| Total  |                                                      | \$2,442 |





"With the most amount of virtual money to play with, we only wish we could have these systems for ourselves, but then again, don't we all?"

**TURBO**  
*The maximum PC.*

At the top of our list are the Turbo builds. With the most amount of virtual money to play with, we only wish we could have these systems for ourselves, but then again, don't we all? These are made for showing off the latest and greatest components, but on the flip side, if we can save a bit of money here and there, we will try to.

The most important component for performance is the GPU. In the Intel machine, we are using an RTX 4090. Last issue, we used the Asus GeForce RTX 4090 TUF Gaming OC 24GB, as this was one of the 'cheapest' at \$3,099. Which is just too much considering we found the replacement, the Zotac GeForce RTX 4090 Gaming Trinity OC

24GB for \$2,849.

Other than the GPU, the PSU changed over from Corsair to Nzxt as the former PSU went up in price, while the Nzxt C1000 comes in at \$239. With a few price fluctuations, such as our CPU increasing and RAM and SSD decreasing, the overall price didn't change much, falling from \$6,072 to \$5,738, a saving of \$334.

Last but not least, we turn our attention to the AMD Turbo. The GPU is the Radeon RX 7900 XTX again – we have found a cheaper model which we will be swapping to. Previously we had the XFX Radeon RX 7900 XTX Speedster MERC 310 Black Edition 24GB, replaced with Asrock's Radeon RX 7900

XTX Phantom Gaming OC 24 GB GPU. Not only is this an overclocked card, but it's currently \$1,799.

We've also replaced the Cooler Master MasterLiquid ML360R RGB 66.7 CFM 360mm with an Asus ROG Strix LC II ARGB 360mm. There was a stock shortage for the Cooler Master AIO that increased the price, this alternative Asus 360mm AIO cooler is more than enough. As we have recently overhauled these systems, the rest of the PC is in a good place. We brought over the same Nzxt C1000 PSU too, due to the same increase in the price of the previous Corsair RM1000. In total, then, this brings the price to \$4,678 from \$4,532.

**AMD INGREDIENTS**

| Part   |                                                             | Price   |
|--------|-------------------------------------------------------------|---------|
| Case   | Phanteks Enthoo Pro 2 Tempered Glass                        | \$349   |
| PSU    | 1000W Nzxt C1000 80+ Gold <b>NEW</b>                        | \$239   |
| Mobo   | Asrock X670E PG Lightning ATX AM5                           | \$449   |
| CPU    | AMD Ryzen 9 7900X                                           | \$699   |
| Cooler | Asus ROG Strix LC II ARGB 360mm <b>NEW</b>                  | \$349   |
| GPU    | Asrock Phantom Gaming OC Radeon RX 7900 XTX 24GB <b>NEW</b> | \$1,799 |
| RAM    | 64GB (2x 32GB) Corsair Vengeance DDR5 CL40 @ 5200MHz        | \$369   |
| SSD    | 1TB WD Black SN850X M.2 PCIe 4.0                            | \$176   |
| HDD    | 6TB WD Blue 5400 HDD                                        | \$189   |
| OS     | Windows 10 Home 64-bit OEM (Windows 11 Compatible)          | \$60    |
| Total  |                                                             | \$4,678 |

**INTEL INGREDIENTS**

| Part   |                                                          | Price   |
|--------|----------------------------------------------------------|---------|
| Case   | Phanteks Enthoo Pro 2 Tempered Glass                     | \$349   |
| PSU    | 1000W Nzxt C1000 80+ Gold <b>NEW</b>                     | \$239   |
| Mobo   | Gigabyte Z790 UD AC ATX LGA 1700                         | \$379   |
| CPU    | Intel Core i9-13900K                                     | \$849   |
| Cooler | Nzxt Kraken X73 73.11 CFM 360mm                          | \$279   |
| GPU    | Zotac GeForce RTX 4090 Gaming Trinity OC 24GB <b>NEW</b> | \$2,849 |
| RAM    | 64GB (2x 32GB) Corsair Vengeance DDR5 CL40 @ 5200MHz     | \$369   |
| SSD    | 1TB WD Black SN850X M.2 PCIe 4.0                         | \$176   |
| HDD    | 6TB WD Blue 5400 HDD                                     | \$189   |
| OS     | Windows 10 Home 64-bit OEM (Windows 11 Compatible)       | \$60    |
| Total  |                                                          | \$5,738 |





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## QUICK TIPS

## The problem solvers

*The APC team field problems across the spectrum of devices and software.*

*Learn a new trick or fix you can use.*

### Video RAM question

Back in the early days of the RTX 3060, I remember a question about the amount of video RAM available and I believe you stated that 2GB would be plenty. Now, these cards are available with 12GB of video RAM! Why is this necessary and what has changed?

**Serpent Lord**

**APC responds:** It's a good question, particularly given the huge amounts of system RAM available in today's PCs. But the answer is straightforward and based on the simple fact that VRAM is optimised for the demands of graphics. The type of RAM – GDDR SDRAM – is optimised for high-bandwidth usage, and along with its placement on the GPU, means it processes graphics far quicker than using system RAM.

As you'd expect, VRAM is used primarily to store and transfer the data needed to render gaming images in all their glorious colour and resolution. If you're not a gamer or don't care for the latest high-res graphics, then 2GB is fine (this may be why we recommended this figure in response to a non-gamer's question), but as a rule of thumb, you'll need a minimum of 4GB for 1080p gaming, and 6 to 8GB for 1440p or 4K.

Why is this? Over the past few years, no doubt fueled by the availability of ever greater amounts of VRAM, developers have focused on producing graphics containing staggering amounts of quality and detail, and those demands on gaming textures and anti-aliasing, to name just two elements in rendering graphics, have forced requirements upward.

That said, don't fixate too much on memory – more VRAM doesn't necessarily mean a card will perform better than another one offering less. For example, AMD's budget RX 5500 XT doesn't render 1440p graphics better than Nvidia's GTX 1660, even though it offers 8GB RAM to the GTX 1660's 6GB.

### Clone or image?

A long time ago, I used Acronis True Image to back up my hard drive. I no longer go this route since when I needed to restore my computer, the backups were corrupted. Now for two desktops

and two laptop computers, I simply buy an extra SSD drive, clone to it, then restart with the clone to verify it works (yes, I must boot to the BIOS and select the new drive). I then unplug the original drive and save it for any disasters. For the laptop, I use an M.2 to USB-C adapter that's cheap.

Not only is cloning faster than making a compressed backup, but backup programs slow down the computers. I now have a new Dell laptop with Windows 11. Could you consider reviewing a few cloning programs so I can pick a good one.

**Dave Shaff**

**APC responds:** Thankfully, APC can meet your requirements while extolling the virtues of image-based backups in a single answer. Any good backup program will offer an option to verify drive images – including True Image, which can be configured to automatically validate images once made (the equivalent of booting from your SSD clone).

Some imaging tools, most notably the APC's favorite Macrium Reflect Home ([www.macrium.com/products/home](http://www.macrium.com/products/home)),

can also be instructed to lower their CPU usage to make the backup process less intrusive on your day-to-day computing. Macrium users will find this option under 'Other Tasks > Edit Defaults and Settings > Advanced Settings > Priority', for example. Remember, your PC only slows down while the backup is being taken, which is true for drive cloning too.

The benefit of image-based backup over cloning is that it supports incremental and differential backups. Once you have a full backup, subsequent ones are much quicker to make – and that includes drive cloning. Macrium Reflect Home supports both types, as does the freebie Hasleo Backup Suite ([www.easyuefi.com](http://www.easyuefi.com)).

APC recommends storing at least two copies of a backup in separate locations, so rather than invest in more SSD drives, why not combine the two methods? Both Macrium Reflect and our new freebie of choice support disk cloning as well as imaging.

This means you can enjoy the best of both worlds in one package – have regular image-based backups made automatically to a centralised backup location to provide a recent backup, then periodically clone your PCs to the dedicated SSDs you bought for redundancy.

### Missing Taskbar icons

After I installed the Windows 11 22H2 update, some of my Taskbar icons were replaced by placeholders. Interestingly it was only the ones for Windows

applications such as Calculator, Store, and My Phone. The icons show up elsewhere on my system and the Taskbar placeholders work when I click them, but I don't always know which is which. I've tried several 'fixes' such as deleting the icon cache, but none have worked. Any suggestions?

**Ned Weinshenker**

### APC responds:

You're not alone in having this problem,

Ned. The web is full of people reporting the same symptoms along with many suggested solutions. Many report the problem only occurring after waking from sleep, at which point, restarting the Windows Explorer process from Task Manager seems to 'fix' the problem – until it happens again. Others suggest simply opening the program from its placeholder icon refreshes the icon but, again, only temporarily.

The problem appears to affect apps installed through the Windows Store – that they're all Microsoft is coincidental. You could try opening the Store, selecting Library, and seeing if any updates are available. Try one or two, and if they fix the icon problem, click 'Update All' to fix the

"After I installed the Windows 11 22H2 update, some of my Taskbar icons were replaced by placeholders. Interestingly it was only the ones for Windows applications such as Calculator, Store, and My Phone."



problem, click 'Update All' to fix the rest. Also, try removing and reinstalling the app to see if it fixes the issue.

Given the ongoing nature of this problem – even full-blown reinstalls have failed in some cases, suggesting the problem remains Microsoft's to fix – the only workaround APC can offer is to either remove Windows Store apps from the Taskbar altogether (pin them to the Start menu instead) or replace the Taskbar with a third-party alternative, like the free version of Winstep Nexus ([www.winstep.net/nexus.asp](http://www.winstep.net/nexus.asp)).

### Block unwanted popup

I've installed the free version of IObit Driver Booster on my system, diligently avoiding all its efforts to install additional software. Now, I keep getting an annoying popup from IObit trying to get me to install iTop VPN. It's bad enough that it appears, but there's no apparent way of closing this window, short of ending the process in Task Manager. How can I rid myself of this popup without removing Driver Booster?

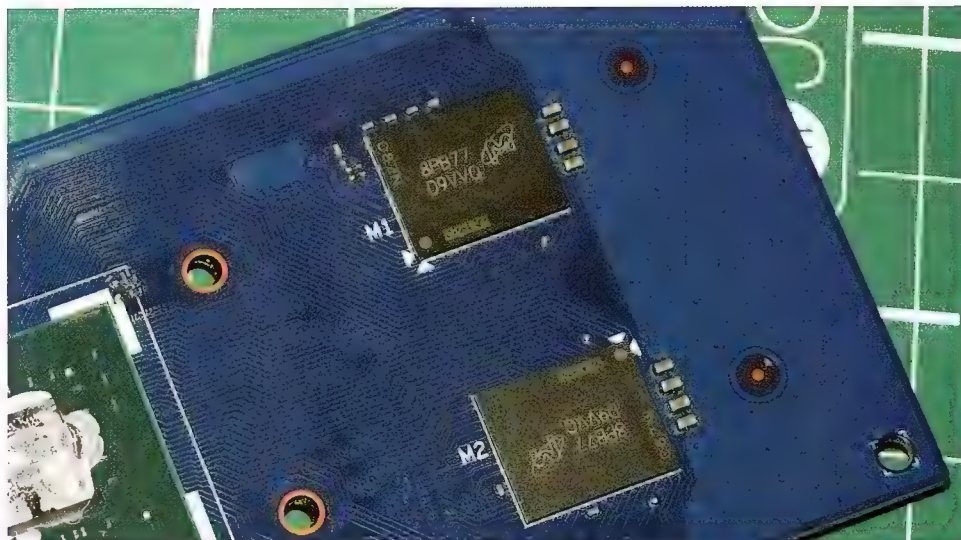
**George J Hampton**

**APC responds:** If you look carefully in the top right-hand corner, there's a close button, practically invisible to the naked eye (roll your mouse over this area and look for the 'Close' popup to appear, then click). Sadly, there appears no way to stop this popup (SafeTips.exe) from appearing, even when disabling the update checker in Driver Booster.

This leaves George with a simple choice: put up with the occasional popup (particularly now he knows how to close it) or consider switching to another driver updater tool. Snappy Driver Installer Origin ([www.snappy-driver-installer.org](http://www.snappy-driver-installer.org)) is free, open-source, and has no popups, although the user interface is chaotic and your security tool (particularly Malwarebytes) may flag certain IP addresses as containing trojans. That's because Snappy Driver uses peer-to-peer (p2p) networking to speed up downloads – the files it downloads are perfectly safe, however, and the warnings can be ignored.

### Backup query

I have a backup software question for a particular need. I have multiple Synology NAS devices, each set up for a specific storage need (files, photos,



You'll need more than 2 GB VRAM for gaming.

video, and computer backup images). Whenever I leave town, I pull out one of the two RAID-1 drives from each NAS to store at an off-site location for safety. This is cumbersome but I don't want to use cloud storage because of the amount of data and cost involved. However, I do have one NAS device with two 20TB drives that should hold everything I need to act as redundant storage for all the others.

Is there any software I can install on one of my PCs that can be configured to store only specific directories from each of my NAS devices on this single 40TB NAS? And can it be used to scan for changes and only update them (like Documents-to-Go does between my iPhone and my PC), so I'm not doing a complete backup every time I move a folder from one NAS to another?

**Nick Kambouris**

**APC responds:** This sounds like a job for file-sync software, Nick, and although Synology's own Drive software comes with ShareSync for keeping specific folders synced between one or more drives in your home, there's another option that won't tie you to Synology software, allowing you to employ it elsewhere.

That option is Syncthing (<https://syncthing.net>), which APC uses to keep all kinds of data synced between our computers, Ubuntu server, and

failsafe QNAP NAS backup. Syncthing runs as a command-line daemon with a web-based frontend and it allows you to set up folder pairs between specific devices. You can have changes in one folder immediately synced to the other – or you can also set it to work one-way only, should you prefer.

Folder pairs can be between two or more devices, and files can be synced over your local network or the internet if required through secure

(end-to-end encrypted) p2p connections, allowing you to take your 40TB NAS with you when you travel, or even house it in a secure remote location, with no additional configuration required.

Syncthing is available as an add-on through the Synology Package Center, and

we recommend reading the app's documentation (<https://docs.syncthing.net/>) to see how it works and how easy it is to set up.

Everything is configured through your PC's web browser using the <https://192.168.x.y:8384/> address (where 192.168.x.y corresponds to the IP address of whichever Synology NAS is currently being set up), and you can also install Syncthing on Windows, macOS, Linux and Android should you want to sync files from computer or mobile to your NAS drives. ■

"I believe you stated that 2GB would be plenty. Now, these cards are available with 12GB of video RAM! Why is this necessary and what has changed?"



## WINDOWS

# Make Windows better

Expert tips for every version.

## WINDOWS 10 &amp; 11

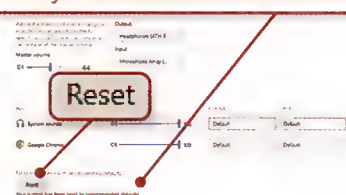
## Reset your audio settings

Windows gives you plenty of options to customise your computer's audio settings to suit your preferences, but it's easy to reset them if you want to start again.

In Windows 10 press Windows key-I to open Settings, then click Sound on the left. Scroll down the main pane on the right and under 'Advanced sound options' click 'App volume and device preferences'. The next page will show your current output and input settings for your master volume, as well as for system sounds and software that's capable of producing audio, such as browsers. Check whether they're what you want, and if not click Reset at the bottom (1 in our screenshot below) to restore them to Microsoft's defaults. You'll see a message in red below confirming this (2).

In Windows 11, open Settings, then click System on the left followed by Sound on the right. Scroll down and click 'Volume mixer' under the Advanced heading, then the Reset button at the bottom of the next page. Once done, Windows will display a tick to confirm this.

Your system has been reset to recommended



## WINDOWS 10 &amp; 11

## Organise your files with coloured tags

The latest version of Files (2.4.30) – the excellent third-party alternative to File Explorer – adds tags to help you organise your files.

There are four colour-coded categories: Home (blue), Work (red), Photos (yellow),

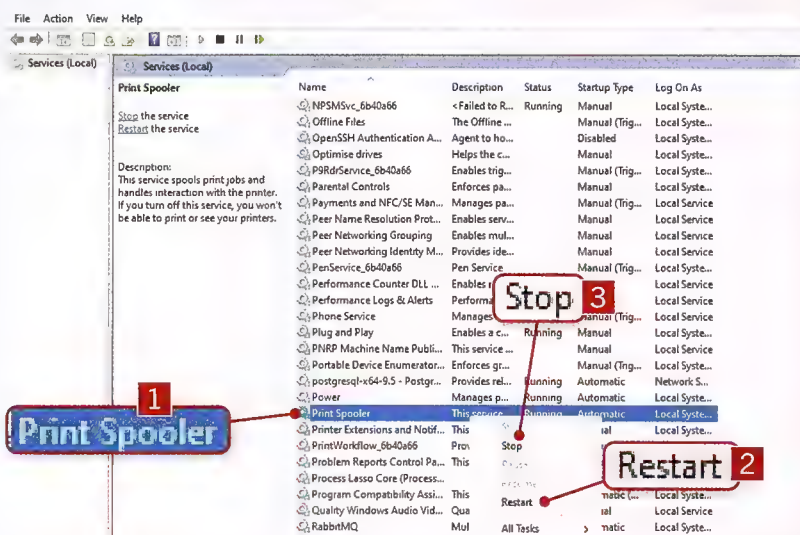


## RESTART PRINT SPOOLER TO FIX PRINTING PROBLEMS ON YOUR PC



If you have persistent problems with your printer, the cause may lie with the Print Spooler system in Windows. This helps to manage the printing process by connecting your software with your printer, and keeps track of which documents have been printed and how many. Restarting this service might fix problems you can't solve any other way.

Press Windows-R then type services.msc and click OK. You'll now see all services running on your system listed alphabetically. Now scroll down and look for the Print Spooler service (1 in our screenshot) Right-click it and select Restart (2). If Print Spooler is already running, right-click and select Stop (3) before restarting.



Important (green). When you right-click a file, you'll see the option to 'Edit file tags'. Click this and you'll see the four category options appear (1 in our screenshot below left). Select a category and the tag will appear next to each file, under the 'File tag' heading (2).

Click any of the colours in the left-hand menu (3, under the Tags heading, and you'll see all the files you've placed in that category.

If you don't already run Files, visit <https://files.community/download> and either install it from the Microsoft Store, or click the 'classic installer' link below.

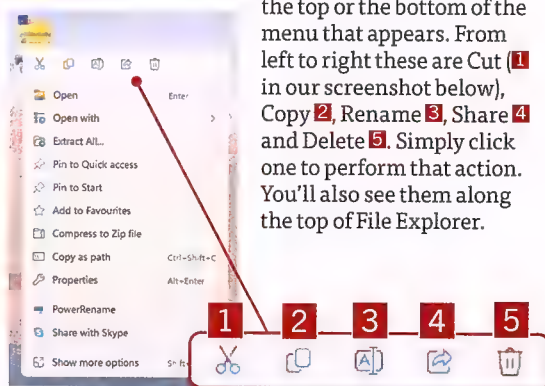
## WINDOWS 11

## Perform tasks using right-click icons

Microsoft chose to declutter the right-click (context) menu in Windows

11, removing options that people had grown used to in previous versions. However, some of these tasks haven't disappeared – they're just available as a clickable icon rather than written as a word. They're easy to miss, though, if you don't know what to look for.

Right-click a file or folder on your desktop and you'll see a row of icons at the top or the bottom of the menu that appears. From left to right these are Cut (1 in our screenshot below), Copy (2), Rename (3), Share (4) and Delete (5). Simply click one to perform that action. You'll also see them along the top of File Explorer.





# Make Office better

Top tips for the best office programs

## Microsoft PowerPoint

### Add contents pages to your presentations

Presentations with lots of slides can be tricky to navigate. To make things easier, try adding a 'table of contents' slide at the start.

First, select the View tab, then click Outline View – this displays a list of all your slides down the left side of the window. Right-click one of the slides, click the small arrow to the right of the Collapse option, then click Collapse All (this leaves only the slide titles visible). Press Ctrl-A to select all the titles, then Ctrl-C to copy them. Next, create a new slide at the start of your presentation in which to put your table of contents. Once you've done this, paste (Ctrl-V) the titles into the text box on the contents slide.

To give your contents page the finishing touch, you can link each title to the appropriate slide, so clicking one will take you to that slide. Highlight the first slide name, right-click it, then select Link.

Now select 'Place in This Document' from the list on the left (see screenshot 1), then double-click the slide you want to link it to (in this example it's the Welcome slide 2). Now repeat this process for the rest of the slide names.

## LibreOffice Calc

### Spell out numbers and currency

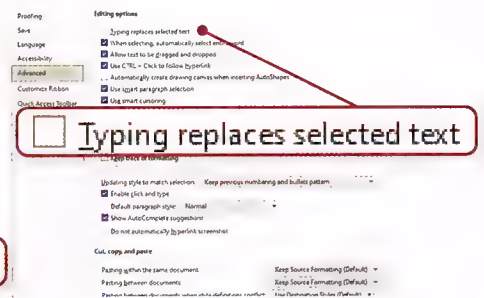
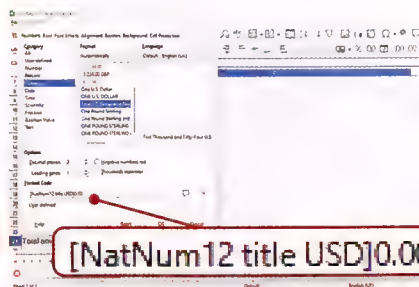
As part of LibreOffice 7.5 (released in February), Calc lets you quickly convert cells containing numbers and currency to spelled-out versions (such as from '100' to 'One Hundred'). First, highlight the cells you want to convert, then right-click and select 'Format Cells...' (or use the Ctrl-1 keyboard shortcut). In the Format Cells window that opens, select from one of the four spelled-out options in the Format pane, then click OK. If you're converting cells containing currency figures, you'll see various options, including one to display pounds and pence. To use a different currency,

change the currency code in the Format Code text accordingly.

## Microsoft Word

### Avoid accidentally deleting text

When you're highlighting lots of sections of text in a long Word document (such as to copy them into an email), it's all too easy to unwittingly press a key and delete them selected text. You can avoid this happening by turning on a hidden feature in Word. Open the File menu (press Alt-F), select Options, then click Advanced. At the top of the list on the right, untick the box labelled 'Typing replaces selected text' (see screenshot below). Click OK to return to your document, then select a portion of text. Ordinarily, if you now pressed Delete (or indeed any other key), the selected portion of text would be deleted. Now, however, pressing Delete does nothing, ensuring your document remains intact.



## ONLYOFFICE

Use new formulas to split spreadsheet cells

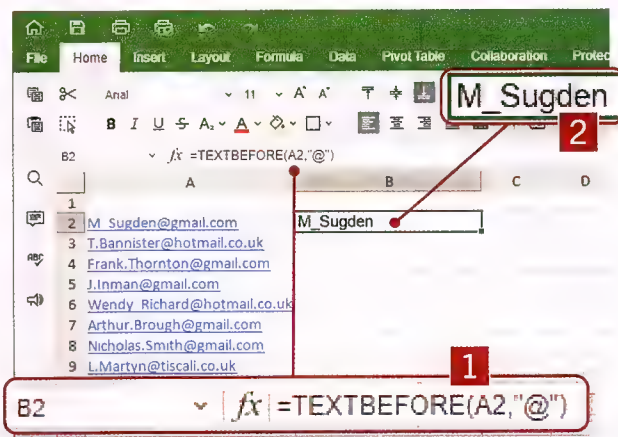
OnlyOffice 7.3 (released in January) includes a set of new formulas that were already available in Microsoft Excel. Two of these formulas make it much easier to chop unwanted text from cells: TEXTBEFORE and TEXTAFTER. As its name suggests, TEXTBEFORE keeps only the text before a character or word you specify, while TEXTAFTER keeps only the text after this point.

In this example, we've got a list of email addresses, but we want to keep only the username – in other words, the text before the '@' symbol. With our first email address in cell A2, in B2 we type =TEXTBEFORE(A2,"@") – 1 in our screenshot. This leaves only the first part of the email address (the person's name) in cell B2 2. If we wanted to keep only the domain name

(for example 'gmail.com'), we'd use the TEXTAFTER formula in the same way: =TEXTAFTER(A2,"@").

Both formulas also let you choose what to display if the character or word you specify isn't found in a cell. To do this, add four commas before the last bracket, then whatever you want to display. If you simply want to display the contents of the original cell (in our case A2), enter that cell reference here.

Alternatively, to display 'Not found', for



example, you would type =TEXTAFTER(A2,"@","Not found").





MAC OS

## Get started with Mastodon

*Fed up with Twitter? Mastodon offers a billionaire-free alternative.*

**IT WILL TAKE**  
20 minutes

**YOU WILL LEARN**  
You will learn what  
Mastodon is and  
how to use it

**YOU'LL NEED**  
A browser, and  
a bit of patience

Apple Mastodon has been a big beneficiary of Elon Musk's Twitter takeover; with Twitter in apparent chaos and lots of previously banned users being allowed back on, many people have been looking for a more pleasant alternative. For many, Mastodon is that alternative. It has very strong anti-abuse rules, and with a bit of effort you can make it just as easy to

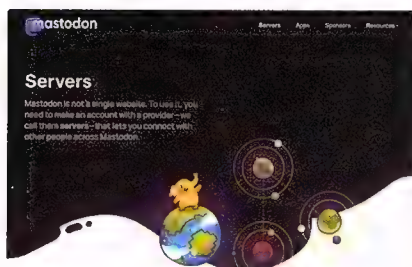
use as Twitter.

Mastodon works a bit like email; in much the same way you can have yourname@ iCloud.com or yourname@gmail.com, there are different Mastodon servers for different people. Mastodon calls them 'instances', and there are instances for journalists, drummers, environmentalists... and so on. You can see posts

from and communicate with people from other instances, just like you can email Gmail users from your iCloud mail. In this tutorial, we'll discover how to get started, and how to find out and follow other people. We'll focus on the desktop here, but there are great iOS apps too.

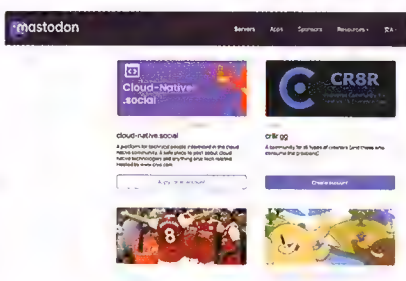
**Carrie Marshall**

### HOW TO SET YOURSELF UP ON MASTODON



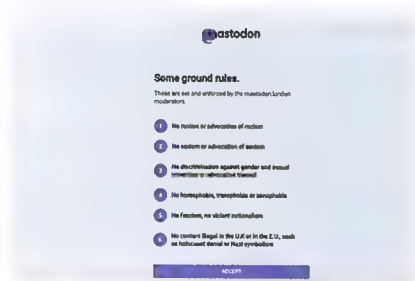
#### 1 FIND YOUR PLACE

Point your browser to [joinmastodon.org](https://joinmastodon.org) and click on Servers. This enables you to see a list of available servers and to sort them. For example, you can find instances dedicated to football or tech, or to specific cities or countries.



#### 2 OPEN AN ACCOUNT

The Servers tab will show one of two buttons below a server name: Create Account or Apply For An Account. The former means anybody can join; the latter means the server vets new users to ensure they're not a potential problem.

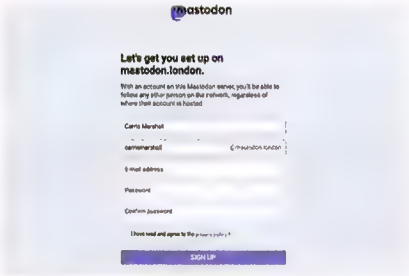


#### 3 READ THE RULES

Every instance has its own set of rules, and breaking them can get you banned from that instance. These rules, for the mastodon.sydney instance, are fairly typical and hardly controversial: nothing illegal, no hate speech, etc.

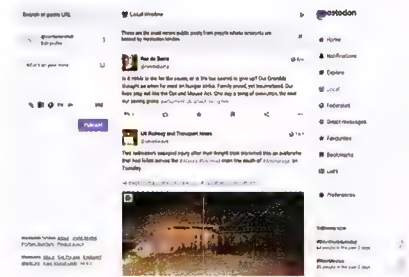


CONTINUED... SET YOURSELF UP ON MASTODON



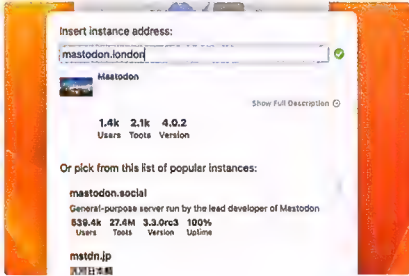
4 ENTER YOUR DETAILS

All you need to do now is sign up with the instance by providing your name, preferred user name and email address. You're signing up with a specific instance, not an app; you can use any app you like to access your account.



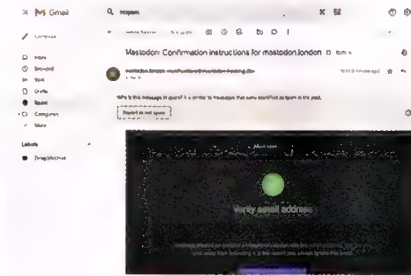
7 LOOK AT LOCAL

There are three views of Mastodon. The standard view is your own feed, which will contain posts from the people you follow. The Local view shows posts published the instance you're on, in this case mastodon.london.



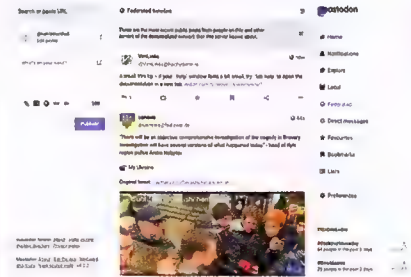
10 PICK YOUR ACCOUNT

You have two choices here; you can log in with an existing Mastodon account, or you can create a new one. We'll use the Mastodon account we just set up, so we'll enter the name of our chosen instance in the field provided.



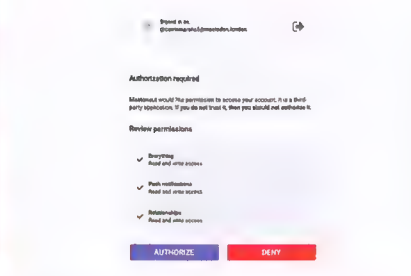
5 CHECK YOUR SPAM

Strangely, Mastodon confirmation emails often go straight to spam or junk. If you don't see an email verification link, it's probably been marked wrongly as spam. Find the message and click the link to activate your account.



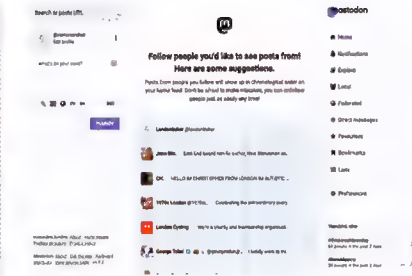
8 JOIN THE FEDERATION

The other view is the Federated view. This enables you to see posts from other Mastodon instances that your particular instance is federated with – essentially, instances that your one says are okay to view.



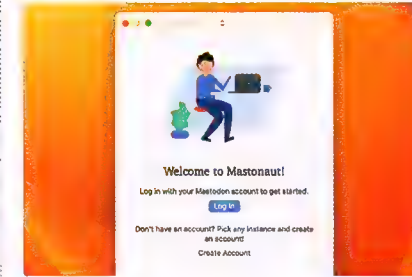
11 AVAUTHORISE YOUR APP

Whether you're on Mac, iPad or iPhone, the app needs to be authorised before it can connect to your account. You should automatically see the screen shown here, and clicking Authorise takes you back to the app.



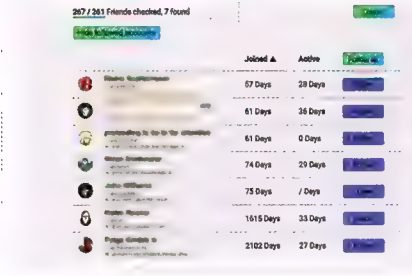
6 LOOK AROUND

This is the web interface for Mastodon, and it has three columns. On the left is where you write your posts and replies. In the middle is where you see other posts, and at the right there are the various options to filter what you see.



9 INSTALL AN APP

There are some good third-party apps for Mastodon for both desktop and iOS, and many of them are free. Although they may look different they all work in much the same way. Let's try the free Mastonaut app (mastonaut.app) for Mac.



12 FIND YOUR PEOPLE

A great way to find people is to see which of your Twitter follows have Mastodon accounts. Movetodon.org can scan your Twitter account, enabling you to follow some or all of the people who've got Mastodon links in their profiles.



## MOBILE DEVICES

# Phone and tablet tips

Brilliant things to do on your device.

## ANDROID

### Disguise your email address in Firefox

Firefox for Android ([tinyurl.com/APC520FF](http://tinyurl.com/APC520FF)) is one of the few mobile browsers that lets you install add-ons – as you can with its desktop counterpart. The latest version of the app (110) adds support for four more extensions that bring useful new features to Firefox on your phone or tablet.

The most notable addition is Mozilla's Firefox Relay add-on, which lets you

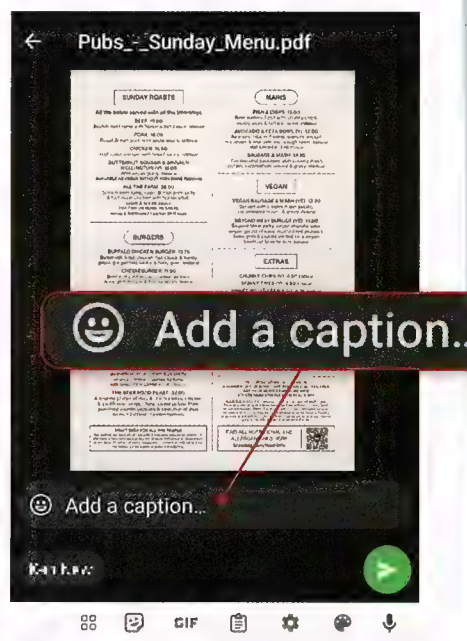


disguise your email address when you sign up with websites, to protect it from spammers and scammers. It works by generating fake email addresses called 'email masks', which forward messages to your real inbox without compromising your privacy.

Tap the three-dot menu and select Add-ons, then tap the plus sign next to Firefox Relay and choose Add. Tap 'Okay, Got it' to confirm the installation. Next, tap the tabs icon in the bottom-right corner of the app and select the Firefox Relay tab. Press 'Sign Up/In' and sign into your Firefox account, or sign up for one if you don't already have one.

Once you're signed in, you'll be taken to the Firefox Relay dashboard, where you can create and manage your email masks. Tap the blue 'Generate new mask' button to create an email mask that can be copied to your clipboard. Alternatively, when you register with a website, tap the purple Firefox Relay icon in the email address box (1 in our screenshot left) and choose 'Generate new mask' (2) to select an existing mask or create a new one.

The free version of Firefox Relay lets you create five email masks. For unlimited masks, you need to upgrade to



Relay Premium for US\$1 a month, which offers extra options including the ability to reply to forwarded messages and block promotional emails.

The other three new add-ons for Firefox for Android are Tampermonkey, CleanURLs and Read Aloud.

## ANDROID & IOS

### Add captions to files you share in WhatsApp

WhatsApp's latest update introduces the ability to add captions to documents you share through

## BEST NEW APPS

What you should install this month



### TOMB RAIDER RELOADED

Free\* | Android [tinyurl.com/APC520TRA](http://tinyurl.com/APC520TRA)  
iOS [tinyurl.com/APC520TRI](http://tinyurl.com/APC520TRI)

Fans of Lara Croft and the *Tomb Raider* franchise will be delighted by this new mobile version of the classic game, which involves you guiding the iconic character through underground tombs, caves, jungles and waterfalls. There are new puzzles to solve, weapons to use and enemies to battle, including a T-Rex.

### Geekbench 6 CPU Benchmark Result

673

Single-Core Score

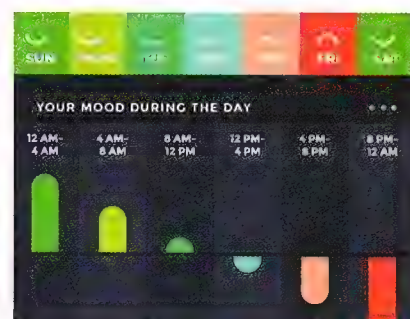
1594

Multi-Core Score

### GEEKBENCH 6

Free | Android [tinyurl.com/APC520GBA](http://tinyurl.com/APC520GBA)  
iOS [tinyurl.com/APC520GBI](http://tinyurl.com/APC520GBI)

Benchmarking tool Geekbench has updated its mobile app in line with its new PC version. It tests the CPU and GPU of your phone or tablet with resource-intensive tasks (which now include several new tests) then lets you compare the results with other users' devices.



### MOODSTORY

Free\*/\$9.99 | Android [tinyurl.com/APC520MOA](http://tinyurl.com/APC520MOA)  
iOS [tinyurl.com/APC520MOI](http://tinyurl.com/APC520MOI)

New to Android, this mood-tracking app lets you record how you're feeling every day without needing to write anything. Simply swipe your screen to specify your current mood on a colour-coded scale of 1 to 6, from red to green. Moodstory will save the data so you can look back and see how and why your mood changes.

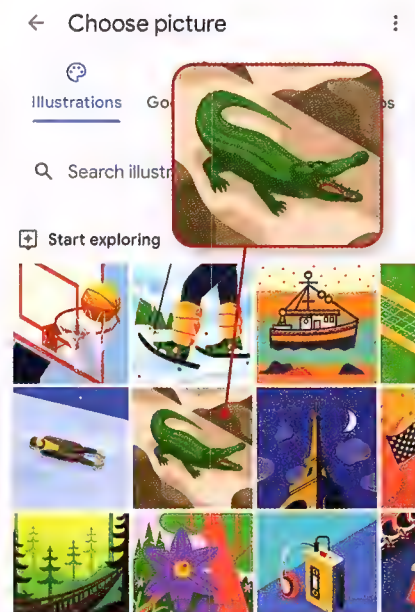




the messaging app. Previously, the option was limited to photos and videos, but it means you can now explain why you're sending someone a particular file, without needing to write a separate message.

To use the new feature, tap the attachment (paperclip) icon in a chat, select Document then the file you want to share – press 'Browse other docs' then the Documents tab if it isn't listed on the Documents screen. Tap 'Add a caption' (see screenshot above left) and type a description of the document (including emojis if you want) then press Send.

Additionally, the iOS version of WhatsApp has finally added Picture-in-Picture (PiP) mode – a feature that's been available in the Android app since late 2018. This allows you to keep chatting in a WhatsApp video call while doing other things on your iPhone. Once you join a video call and minimise the app, it will automatically show the video in a floating PiP window that overlays other apps.



## iOS View useful business information in Apple Maps

Apple Maps has long been in the shadow of the much more popular Google Maps, and its poor rating in the Apple App Store – a mere 2.9 out of 5 (see [tinyurl.com/APC520MAPS](https://tinyurl.com/APC520MAPS)) – suggests many users find it underwhelming. Apple's latest update to Maps should make the app more appealing by adding useful information about businesses.

For example, when you search for a hotel address in Apple Maps, the information panel will now include the hotel's distance from your current location (see screenshot above left), directions to it, details of its rates and payment options, contact info and a link to its website to make a reservation.

Businesses can also include photos and news of their latest promotions on their Apple Maps pages, while services that offer food and drink can provide an option to order a takeaway.

Google Maps already offers this type of content for most businesses, but at least Apple Maps is no longer lagging so far behind.

## ANDROID Customise your contacts' profile pictures

Some people add profile pictures to their Google accounts, which makes them easy to identify in your Contacts list, but plenty don't bother. This means their entries are accompanied by coloured circles containing the first letter of their names, which makes them difficult to distinguish from adjacent contacts. To make things more interesting and fun, Google now lets you customise your contacts' profile icons with quirky pictures from its Illustrations collection.

Open the Contacts app on your Android phone or tablet, select a contact whose picture you want to change and tap the Edit (pencil) icon in the top-right corner. Press 'Add picture' and browse the hundreds of colourful options on the Illustrations tab (see screenshot left). These are organised into categories such as Food, Symbols, Animals, Nature and 'Sports and Recreation', and you can use the search box to find a specific design.

Select a graphic to adjust the colour of its subject and background, and crop and rotate it as required. Tap 'Choose' when done to set the illustration as the contact's profile picture – only you will be able to see this, so don't worry about getting their approval.

To change your own profile picture, tap the icon in the top-right corner of the Contacts app and select 'Manage your Google account', then 'Personal info'. Select 'Photo' then 'Set profile photo' and choose the image you want to use. ■

## BEST APPS FOR... Collecting hobbies



### Trending releases



### Most Collected

### Most Wanted

### Latest Additions

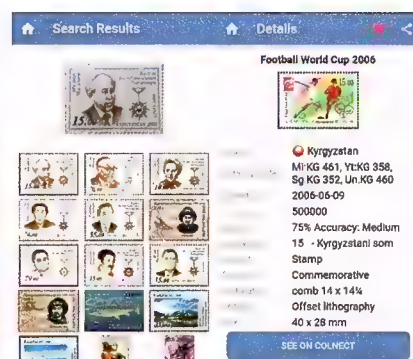
### Explore Genres

## DISCOGS

Free | Android [tinyurl.com/APC520DIS](https://tinyurl.com/APC520DIS)  
iOS [tinyurl.com/APC520DISI](https://tinyurl.com/APC520DISI)

No record collector should be without the Discogs app, which makes it easy to catalogue your vinyl collection and check the value of the singles and albums you own. You can scan barcodes or enter details manually to find matches in the massive Discogs database, and share a list of your 'most wanted' items.

**Best for Valuing your record collection**



## STAMP IDENTIFIER

Free\* | Android [tinyurl.com/APC520STA](https://tinyurl.com/APC520STA)  
iOS [tinyurl.com/APC520STAI](https://tinyurl.com/APC520STAI)

This simple app from the Collectors Community helps you identify stamps from around the world by taking photos of them with your phone's camera. It tells you the stamp's country of origin, issue date, print-run size and other useful info, and provides catalogue codes so you can check its current value.

**Best for Identifying postage stamps**



## Find it faster!

Traversing hundreds of GBs of data and thousands of folders is a tall order, unless you're Shashank Sharma, who knows just the tool to find files fast.



Most distros nowadays feature a desktop search tool out of the box to help you quickly find the files you're looking for. This is incredibly useful with vast disk space and an ever-increasing number of stored files and directories. But for CLI users, there have always been a few trusted tools to quickly fetch files. Chief among them is Find.

As the name implies, the Find utility strives to help you find files. What sets it apart? The ability to identify files based on more than just filenames. When looking up files, you can use a variety of parameters, such as name, approximate name, permissions, last modified, file type and so on, to quickly narrow down the file you're looking for. You can also restrict results to directories, and even find files by matching the contents. All told, Find is one of the most rewarding tools to master for all who are fond of the CLI.

Unlike most CLI tools featured in this column, the Find utility is already part of your Linux distro, so you don't have to worry about installation. In fact, it's part of the findutils package, which comprises four robust CLI utilities: Find, Locate, Xargs and Updatedb. Check the box for more information about findutils.

### Finders keepers

Don't you just hate it when you remember the name of a file you're looking for but can't remember where you placed it? Such a situation

```

1 linuxlala@playground: /media/linuxlala/Stuffsies/00.Mensch.Law
1 linuxlala@playground: /media/linuxlala/Stuffsies/00.Mensch.Law$ find -type f -perm
m 777 -print -exec chmod 644 {} \;
./00 Mensch Law/00-case-index.ods
./00 Mensch Law/AAIDU AICTE EXAM -- Result/00 FINAL CERTIFICATE.pdf
./00 Mensch Law/AAIDU AICTE EXAM -- Result/00 FINAL MARKS.pdf
./00 Mensch Law/AAIDU AICTE EXAM -- Result/15800120-certificate.pdf
./00 Mensch Law/AAIDU AICTE EXAM -- Result/circular-du.pdf
./00 Mensch Law/AAIDU AICTE EXAM -- Result/Screenshot 2019-03-03 Results.png
./00 Mensch Law/AAIDU AICTE EXAM -- Result/UG RESULT REVISED 27.09.2019.pdf
./00 Mensch Law/adjournment-stip.doc
./00 Mensch Law/baleshwar-sign-no-bg.png
./00 Mensch Law/BCD && BCI && SC E-Committee/BCI DETAILS OF ADVOCATE.pdf
./00 Mensch Law/court-fees-delhi.jpg
./00 Mensch Law/Design/Law-office-interior-design-ideas-law-office-interior-desi
gn-ideas-interior-law-office-interior-design-ideas-modest-and-law-office.jpg
./00 Mensch Law/Design/Quotation for Y-57 Chamber.pdf
./00 Mensch Law/Design/Y-57 & 58 chamber-Model.pdf
./00 Mensch Law/Design/Y-57 & 58 chamber-Model1.pdf
./00 Mensch Law/Health Policy/ECard 5033711.pdf
./00 Mensch Law/Health Policy/ECard 5033711E.pdf
./00 Mensch Law/JSM-intial-blue.png
./00 Mensch Law/JSM-intial.png
./00 Mensch Law/JSM-sign-blue.png
  
```

Use the `-print` action, especially when using Find in combination with another command, to see all files affected by your specified operation.

is easily remedied with Find.

It assumes you wish to search the current working directory if no directory is specified. You can also use a battery of tests and options to identify the file or directory you're looking for, which is useful if you wish to narrow down matches. For instance, you can use the `type f` option when searching for files, or `-type d` if you only want to look up directories. The following table lists some of the common operations you

can use to restrict the search results.

| File type            | Description                           |
|----------------------|---------------------------------------|
| <code>type -f</code> | Limits results to files only          |
| <code>type -d</code> | Limits results to directories only    |
| <code>type -l</code> | Limits results to symbolic links only |

If the name of the file you're looking for has the word 'foo' in it, you can run `find ~/Documents -type f -name "foo.odt"` which recursively looks through the ~/Documents directory for all ODT files that match the given wildcard. You can also use wildcards in place of the file extension, if necessary. Your search pattern must always be enclosed in quotation marks, and if you don't use wildcards, Find only returns results that exactly match the given keyword. For instance, if you have a number of files named APC-520-foo.txt, APC-519-bear.txt, and so on, the `find -type f -name "APC"` command does not yield any results because there's no file named 'APC'. To find all matching results, you have to look for "APC\*".

In our examples, `-name` is just one of the tests supported by Find to help you narrow down the search.

## OTHER UTILITIES

While the Find utility is peerless when looking for files, there are other CLI utilities available to find files and even executable binaries.

As we're on the subject of finding files, another utility you should try is Locate. You'll find it faster than Find in fetching results. This is because, unlike Find, which performs the search in real time, Locate works by matching your specified keyword in its database. The database can be updated manually by running the `updatedb` command. The downside to Locate is that it can't yield results of files that were created since the last time the database was updated.

You can similarly use the `which` command to find binaries. If you routinely install packages and utilities using different package managers and even manually, it might become hard to remember what utility was installed in which directory. Cue the `which` command. If you also want to know where the source and man page for a command are located, you can turn to the `whereis` command.

```

$ which cargo
/usr/bin/cargo
$ whereis cargo
cargo: /usr/bin/cargo /usr/share/cargo /usr/
share/man/man1/cargo.1.gz
  
```



| Find tests         | Explanation                                                                                       |
|--------------------|---------------------------------------------------------------------------------------------------|
| -name <pattern>    | Performs a case-sensitive search for <pattern>                                                    |
| -iname <pattern>   | Performs a case-insensitive search for <pattern>                                                  |
| -size n            | Matches files of size n                                                                           |
| -size +n           | Matches files larger than size n                                                                  |
| -size -n           | Matches files smaller than size n                                                                 |
| -newer <file>      | Matches files and directories whose contents were modified more recently than the specified file. |
| -mmin n            | Matches files or directories whose contents were last modified n minutes ago                      |
| -mtime n           | Matches files or directories whose contents were last modified n*24 hours ago                     |
| -atime n           | Matches files last accessed n*24 hours ago                                                        |
| -perm <permission> | Matches files with the defined permission                                                         |

Refer to the man page for a complete list of tests. When using the `-size` test, you can specify the size in bytes (`c`), kilobytes (`k`), megabytes (`M`) or gigabytes (`G`). Actually, the man page uses the terms kikiytes, mebibytes and gibibytes, but these are generally used interchangeably with the more usual file size names.

The `-mtime n` test is used to identify files or directories that were last modified `n*24` hours ago. So, `-mtime 1` would identify files or directories that were last modified a day ago, while `-mtime 2` would restrict results to those that were modified two days ago.

```
$ find ~/Desktop/ -mtime 1
/home/linuxlala/Desktop/
/home/linuxlala/Desktop/Bare Acts
/home/linuxlala/Desktop/notes-
applications-arguments.pdf
$ find -mtime 15
./Arbitration/Hc-13-Zexus-vs-AR-Airways/
complaint.docx
./Arbitration/Hc-13-Zexus-vs-AR-Airways/
Hc-Reply-Zexus.docx
```

You can also use logical operators such as `and`, `or` or `not` to combine tests to have better control over the search results. For instance, if you wanted files that match the pattern `'foo'` but were less than 2MB in size, you would have to run the `find -name "foo" -and -size -2M` command. Here, we use the `-and` logical operator to split the two tests we wish to use: `-name` and `-size`.



**QUICK TIP!**  
When using `()` to combine tests, you must remember to escape `()` the brackets. Also, you need to leave a space after you open and just before you close the brackets.

| Operator  | Description                                                            |
|-----------|------------------------------------------------------------------------|
| -and / -a | Yields results that match the test on both sides of the operator       |
| -or / -o  | Yields results that match either test                                  |
| -note / ! | Yields results that don't match the test                               |
| ()        | Can be used to group tests and operators to create complex expressions |

The following example showcases how you can use multiple tests and combinations of operators to narrow down the file you're looking for:

```
$ ls
HC-somename.pdf HC-somen.jpg
HHhHcC-somename.jpg
$ find \( -iname "HC*" -size +2M \) -and
-not \( -iname "*.jpg" -or -iname "*.png" \)
./HC-somename.pdf
```

In this example, we want files that have the letters `'hc'` in the name, upper-case or otherwise, and for the file to be more than 2MB in size, but aren't image files.

**Take action**  
There's a number of operations that

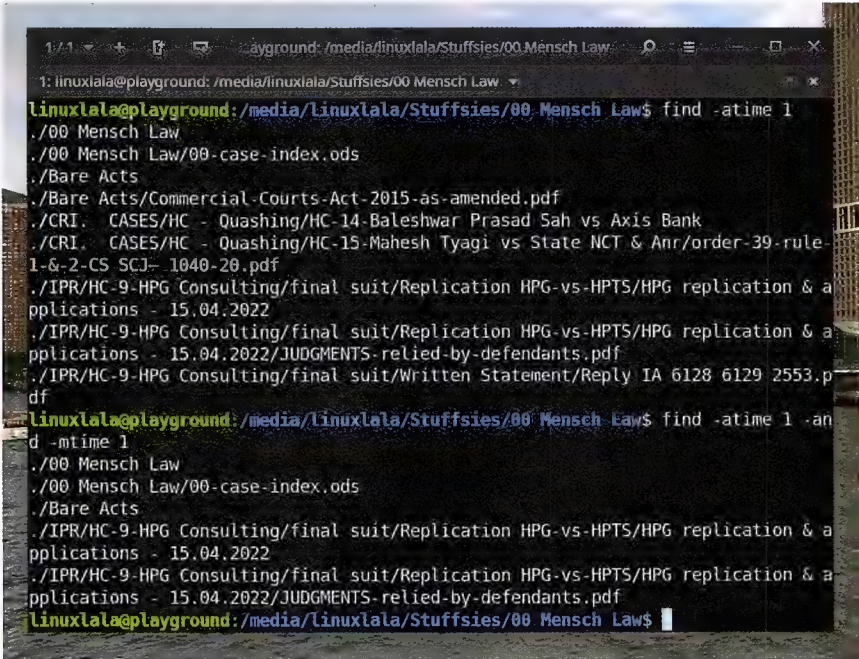
you can perform on the files that Find fetches for you. The default is to print all matching files or directories on the screen.

But you can also choose to delete a file using the `-delete` action. For instance, the command `find -f -name "HC*" -delete` deletes all files that match the specified pattern.

You should be extremely cautious when using the `-delete` action with Find because the utility doesn't ask for a confirmation before going ahead and deleting the matching files.

It's also possible to run different commands on all matching files. For instance, if you have several shell scripts that you wish to mark as executable, you can couple `find` with `chmod` to perform the operation with a single command. The command `find -type f -name "*.sh" -exec chmod +x {} \;` can be used to identify all shell scripts and make them executable. You can similarly combine `find` with the `chmod` command to modify permissions of matching files, and various other commands to simplify your tasks. ■

"Unlike most CLI tools featured in this column, the Find utility is already part of your Linux distro, so you don't have to worry about installation."



The man page is a must-read if you wish to make sense of the full capabilities of the Find utility.



# Control your Pi robot with Bluetooth

*Loving the feeling of power, Les Pounder shows us how to remote-control your robot with Android devices and Bluetooth.*

## YOU'LL NEED THIS

- The robot build from part two
- Your ongoing robot project
- Android device
- Get the code, diagrams, images and more via this Github link: [tinyurl.com/APC520ROBOT](https://tinyurl.com/APC520ROBOT)



At the end of part three, we had built our robot from a kit, tested the motors and looked at a number of sensors. We intentionally kept the choices vague, remembering that robotics is a personal project. You are bringing life to a project that can navigate the world around it. It has a personality created in code, but with a mind of its own at times.

For this part of the build, we are going to have a little fun with our robot. No sensors are required – all we need is an old Android phone or tablet (even some Chromebooks will work) and a little space. We are going to use a free Android app to bring remote control to our robot. Thanks to the newer Raspberry Pi's Bluetooth capabilities, we can remotely connect and control our robot. In a world where sensors can help a robot navigate its environment, it is informative (and fun) to get hands-on and learn how effective our custom Python robot library is. After this project, you will undoubtedly

want to tweak the values stored in your robot.py library, as you will now have a better understanding of what speeds are necessary for different terrains.

The most important thing is that you have some fun with this part!

## Blue Dot

Sometimes we need to get hands-on with a robot. Just like controlling an RC car, we need to get our hands on the controls and take the robot for a spin. So, how can we do this – do we need radio control gear? Well, no. Long-time Raspberry Pi Foundation employee and friend of ours Martin O'Hanlon created Blue Dot, a simple controller that uses an Android device and Bluetooth to communicate with a Raspberry Pi. Blue Dot needs Bluetooth, so a Raspberry Pi 3, 4, Zero W or Zero 2 W is necessary. You could use a Bluetooth dongle with another model of Raspberry Pi, but we haven't tested that, so it is an exercise for you.

Go to the Google Play Store and search for Blue Dot by Martin O'Hanlon. Install the app but don't open it yet.

Go to your Android device's settings and then go to Connected Devices. Click on Bluetooth and start the process of searching for and pairing to a device. On your Raspberry Pi, go to the top-right Bluetooth menu and select Make Discoverable. Go back to your Android device and after a while you will see **raspberrypi** appear. Select this and confirm the pairing request on your Android device and the Pi. If it doesn't work the first time, try again, Bluetooth can be a little tricky. Your Android device and Pi should now be connected.

On the Raspberry Pi, open a terminal and install Blue Dot using the Python package

manager, Pip.

```
$ sudo pip3 install bluedot
```

Let's test the connection. From the main Raspberry Pi menu, click on Programming > Thonny. We're going to write a quick connection test that will trigger a response when the blue dot is pressed.

We'll start by importing the BlueDot library:

```
from bluedot import BlueDot
```

Create an object, bd, that we will use to interact with the library:

```
bd = BlueDot()
```

Wait for the user to press the blue button. This is a blocker – the code will sit there, until something happens:

```
bd.wait_for_press()
```

Print a message to the user confirming that the button has been pressed:

```
print("You pressed the blue dot!")
```

Save the code as bd-connection.py and then click Run to start. The code sits there, waiting for a connection. On your Android device, open the Blue Dot app, select your Raspberry Pi from the list of available connections. Once connected, a big blue dot appears. Click on the dot and look at your Python code – you will see that our message has been printed to the Python shell. Our connection works, so let's further explore Blue Dot.

Our next step is to create a script that enables us to control the robot using Blue Dot. As we touch the top, bottom, left and right of the dot, the robot will react and move accordingly. We'll also put the emergency stop function at the centre of the dot.

In Thonny, create a new file and then import the Bluedot library:

```
from bluedot import BlueDot
import our custom robot control library.
import robot
```

Import the pause function from the signal library; this



Connected to raspberrypi



The eponymous Blue Dot is perhaps the simplest robot controller out there for the Raspberry Pi.



stops our code from ending. Then import sleep from the time library. This is used to control how long the motors are on.

```
from signal import pause
from time import sleep
```

Next, create a variable called delay. Here we store a general delay time, in seconds, for the motors. We can tinker with this value, shorter or longer, depending on how we want the robot to react.

```
delay = 1
```

Our Blue Dot controller uses a function, dpad(), that takes one argument: the position of where we press.

```
def dpad(pos):
```

Using a conditional test, we check which position has been pressed. First up, the top of the dot. If the top is pressed, we print the direction to the Python shell, then call the robot.forward function from our library. We set the speed to 0.5 (50 percent) to ensure that our robot doesn't run away. A short sleep keeps the motors running for the time specified in the delay variable. Finally, we call the stop function to bring our robot to a halt.

```
if pos.top:
    print("Forward")
    robot.forward(0.5)
    sleep(delay)
    robot.stop()
```

The next test in the conditional sequence is elif (else if) and it looks for a press of the bottom part of the dot. This uses the same sequence, but instead prints Backward and moves the motors in reverse.

```
elif pos.bottom:
    print("Backward")
    robot.backward(0.5)
    sleep(delay)
```

## BLUE DOT

Created by Martin O'Hanlon, Blue Dot was created to fulfil the need of remote interaction with a Raspberry Pi. We've used it to create a simple robot controller but Blue Dot is incredibly sophisticated, yet easy to use. O'Hanlon is a pragmatic programmer and is always looking for and often creating tools to fix the problems faced by the Raspberry Pi community. Working as part of the Raspberry Pi Foundation's Picademy,

O'Hanlon saw the issues that many newcomers faced, hence Blue Dot was born. The Python library is easy to use, as we've demonstrated, but we can do so much more. Custom controller layouts, sliders, joysticks and swipe inputs are all easily used in your project. A quick introduction to Blue Dot is a remote camera trigger, where pressing the button triggers the camera to take a picture. If your robot uses a tank

configuration, Blue Dot has sliders that mimic the controls of a real tank. If you need lightning-fast inputs, Blue Dot's Speed, Angle and Distance functions handle the direction, distance and the speed in which the user swipes.

You can read more about Blue Dot at <https://bluedot.readthedocs.io/en/latest/index.html>. The provided examples (recipes) illustrate how to use all of the advanced functionality.



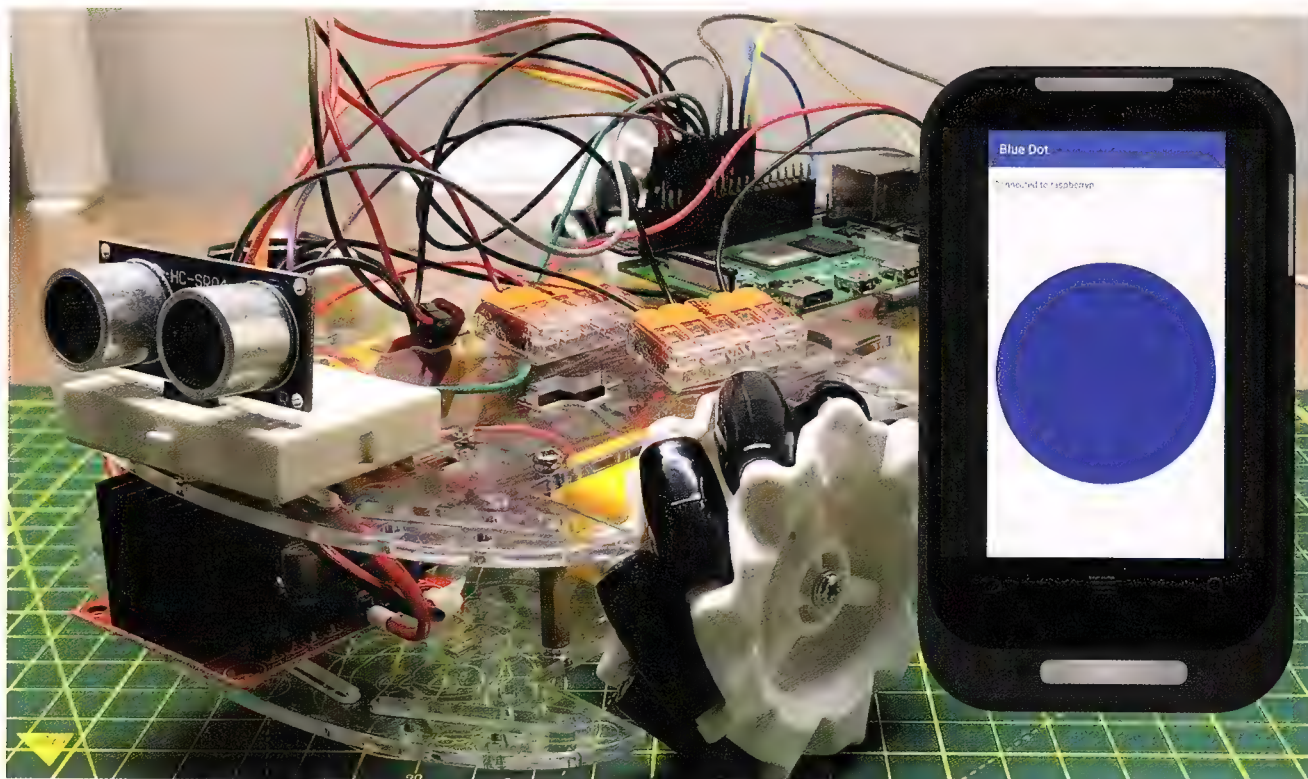
You need to pair your Android device to your Raspberry Pi using the Settings > Connected Devices menu.



### GENIUS TIP!

Test your robot on different surfaces or terrains. Carpets typically offer great grip but need more power to move the robot. Wood floors are slippery – great for drifting, but bad for fast control. Either lower your speeds or buy grippy tyres.





With Blue Dot, our robot can have fun doing doughnuts, running amok across the living room.

Stop right there, though! We can make this better! When we created the directional controls in our robot library, we used PWM (pulse width modulation) for precise speed control of the motors. Well, Blue Dot can use the distance from the centre of the dot as a means to give us precise control of the motor speed. Luckily for us, Blue Dot returns a value between 0 and 1.0 – exactly what our robot library expects for PWM control. So, let's write a new test script.

Create a new file in Thonny and import Blue Dot and our robot library:  
`from bluedot import BlueDot`  
`import robot`

Next, import `pause` from `signal` to prevent the code from exiting:  
`from signal import pause`

Now create the `bd` object that enables us to use Blue Dot:

```
bd = BlueDot()
```

Create a function, `dpad()`, which uses the position of the user's finger as a means to offer fine input control.

```
def dpad(pos):
```

Using the same conditional test, check whether the user has pressed the top of the dot. If this is true, then we

**"If your robot is misbehaving in the arena, then a remote switch could just prevent an accident or broken bot."**

save the current position to a variable called `speed`. The value returned from Blue Dot is incredibly precise, but we only need two decimals places of accuracy so we use `round`

and 2 to set this. We print the direction and speed to the Python shell and then call our robot library to move the robot

forward at the detected speed:

```
speed = round(pos.distance,2)
print("Forward:",speed)
robot.forward(speed)
```

Repeating the process, we now create an `elif` (else if) condition that looks for any inputs on the bottom of the dot. It resets the `speed` variable to the new position and prints the direction and speed to the user before setting the robot to move in the chosen direction and our preferred speed:

```
elif pos.bottom:
    speed = round(pos.distance,2)
    print("Backward:",speed)
    robot.backward(speed)
```

Now we set the conditional for spin left. Again we use the user's finger to set the speed of the spin. Note that a high



### GENIUS TIP!

Before taking your robot for a spin, now is the time to get some cable ties and double-sided tape, and secure your components to the chassis. Nobody wants to see a robot tear itself apart, or for your Raspberry Pi to break.

## Blue Dot

### Connect

raspberrypi  
 DC:A6:32:03:EE:56

VIIDO SOUND  
 41:42:96:6F:A8:FB

RR-1177

In Blue Dot, we need to make sure we select the correct device from the list. It unhelpfully lists all the Bluetooth devices we have ever used.



11:24



## Blue Dot

Martin O'Hanlon

4.6 ★

172 reviews

10K+

Downloads



PEGI 3

Install

Install on phone. More devices available.

Make sure that you download and install Blue Dot by Martin O'Hanlon – this is the official and correct app for Android.

speed will be fun to watch, but will introduce a devilishly violent speed to our doughnuts. Make sure the components (sensors, motor controllers, Raspberry Pi and batteries) are firmly attached.

elif pos.left:

```
speed = round(pos.distance,2)
print("Spin Left:",speed)
robot.spin_left(speed)
```

We now need to repeat the process one last time for spinning right:

elif pos.right:

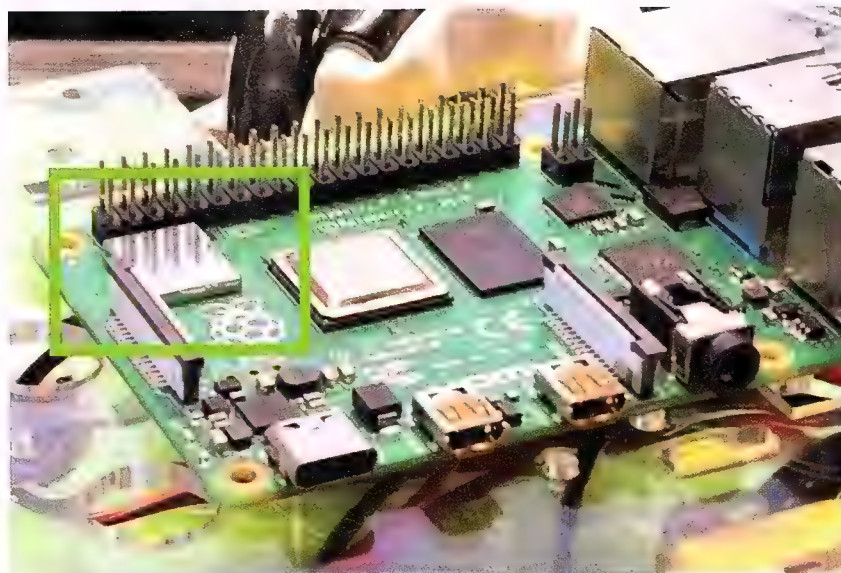
```
speed = round(pos.distance,2)
print("Spin Right:",speed)
robot.spin_right(speed)
```

Here is where things get a little different. We are now out of the function and we have three statuses to keep track of. The first is when Blue Dot is pressed. If this happens, it calls the `dpad()` function and moves the robot in the chosen direction. If we release our finger, then the `robot.stop()` function is called as we are now not in control



### GENIUS TIP!

Blue Dot will work with many Android devices, including the one hidden at the back of a drawer. Reuse an old Android phone as a controller. Not got an old Android phone? They can be picked up for very little money. It doesn't need to fully work, just Bluetooth, the screen and Wi-Fi is all you need.



That silver package (highlighted) is where the Raspberry Pi's wireless connectivity lives. Wi-Fi and Bluetooth are present, with antennas built into the board.

of the robot. In order to keep everything moving, we need to keep our finger on the dot, moving it around to choose a new direction and set a new speed. The `bd.when_moved` status also runs the `dpad()` function and keeps the motors turning.

```
bd.when_pressed = dpad
bd.when_moved = dpad
bd.when_released = robot.stop()
```

Add a `pause()` to prevent the code from exiting, forcing the code to keep looking for user input.

Save the code as `fine-speed-control.py` and click on Run to start. Open the Blue Dot app on your phone and then connect to your Raspberry Pi. Now try out the controls and remember to keep your finger on the Blue Dot, otherwise the robot will stop moving.

### Go nuts for doughnuts

We've had some fun with our robot. Sure, this part of the project hasn't seen the robot navigate an assault course

using just sensors. What we have done is create a connection between a smartphone and our robot, using an app to control the robot and provide a fun means to introduce robotics to a younger generation. Learning to manually control the robot is a great way to understand how the functions in our robot.py library work. We get to feel how fast it moves and spins, and how responsive it can be.

Do we need to tweak anything? If so, go back to `robot.py` and make those changes. Blue Dot can also be used as a remote kill switch. If your robot is misbehaving in the arena (we remember a time with Raspberry Pi co-founder Pete Lomas when our robot climbed over the maze walls with no user input), then a remote switch could easily prevent an accident or broken little bot.

Robotics is fun, so let your hair down and do some doughnuts with your robot. ■

## NEED INPUT!

Much like the movie robot Johnny Five, who always craves input, there are many different means to remotely control a Raspberry Pi robot. Inputs from Zeth <https://github.com/zeth/inputs> is a favourite of ours. This Python library is so simple to use and it works with a range of controllers. From the humble keyboard and mouse, all the way to Xbox controllers, you can easily connect them and use them to control any

project. Why do we like this library over, say, PyGame? Well PyGame requires us to have a PyGame window open and in focus on the desktop. If we are using a headless setup – a robot, for example – we can't see the PyGame window. Inputs just reads the raw input and interprets it for us. We've used Inputs to control Python's Turtle library to draw Etch-A-Sketch style images in a window, but we could easily just import

our robot library and then use Inputs to drive our robot.

If you want to use your Bluetooth controllers with your Raspberry Pi, then take a look at [www.tomshardware.com/how-to/use-playstation-xbox-controllers-raspberry-pi](http://www.tomshardware.com/how-to/use-playstation-xbox-controllers-raspberry-pi) where there are details on how to use `xboxdrv` to connect an Xbox One controller to a Raspberry Pi, and SixPair, which connects a PlayStation 3 controller.





GAMES

## Everspace 2

This might be the *Diablo* in space we've always wanted.

■ \$74.99 | PC, PS4/5, XB1/S/X, Mac | [everspace.game](https://everspace.game)

*Everspace 2* is not *Freelancer*, though it resembles this classic. If anything, it's better. It's the same sort of third-person open worldish interplanetary adventure, *Diablo* in space, an RPG in which you play a conglomeration of engines and lasers as much as its pilot, and a sequel to 2017's *Everspace*. It's different from its predecessor in one crucial way: the roguelike elements are gone. In *Everspace*, death was inevitable, baked into the game so that credits earned during a run could be used to buy perks and improve your character for the next one. Not so in *Everspace 2*, where death merely brings up the reload checkpoint screen and a chance to try again.

Following a Kickstarter campaign and a period in Early Access it's a very polished title, and can be a ridiculously good looking game, all floating rocks and wreckage, the trails left by other ships visible through clouds of dust that drift

between objects. Minefields glow red in the darkness, radiation fields are speckled with golden particles you'll want to get close to before backing away swiftly. Stars cause explosions of bloom and flare when you turn to face them, while planets have concentric ring systems and automated installations are all blinking lights and chunky metal.

New ships can be bought from bases with ship dealers, but you'll need a lot of credits. Most ship upgrades, therefore, come in the form of new guns, secondary weapons such as homing missiles, and special attacks like a static electricity surge that can knock out nearby ships. These need to be charged before you can use them, like a *Street Fighter* super, and there's a recharging shield (some only charge when you boost), armour plating, nanobots to make repairs, damage limitation devices, modifications for your weapons so they do more damage, disable

shields or earn you more XP from a kill.

Ship handling is distinctly arcadey, with full 3D movement and the ability to precisely jet up and down, which comes in very handy when squeezing into small gaps. Enemies are fast, and combat doesn't become the turning contests seen in *Freelancer* where you latched onto an opponent's tail and followed it wherever it went until it went boom. Turning off inertial dampening for a more Newtonian approach to propulsion, and moving into first-person view, make the game a more tricky proposition.

So, an expertly crafted space adventure? Yes. One of the best examples of this genre we've ever seen? Also yes, with the caveat that it's a style of game that's been sadly under-represented in recent years. The lack of heavy simulation elements and emphasis on combat makes this a game that's perfect for a quick blast as well as longer play sessions, but it's also a satisfying and, thanks to all the side missions, really quite long adventure.



Shooting, looting and RPGing in space has rarely looked so good as it does in Rockfish Games' *Everspace 2*.

Ian Evenden

★★★★★



DREAMS IN THE WITCH HOUSE

Starvation could be the least of your problems.

■ \$16.25 | PC | twitter.com/atombraingames

Dreams in the Witch House is based on a Cthulhu Mythos story by Lovecraft that isn't considered one of his best. The game, a point-and-click survival and library simulator, finds Walter in the cold, rat-infested attic ready for the cold, rainy spring term at Miskatonic University, where he's studying physics and maths as well as working on his side theory about the interconnectedness of science and the occult.

Elsewhere, witches have plans for him, and he may find himself extremely interconnected with the occult indeed. The goal of the game is simply to survive for two months while Walter's health and sanity are chipped away.

And while it may look like a puzzle-solving adventure as you dig tweezers out of floorboards to pry broken keys out of locks, much of the game involves seeing to Walter's needs. He gets hungry, cold, wet, ill, insane... and he especially gets broke. An allowance arrives each week, there are financial bonuses for passing exams, and he can do odd jobs, but with food, medicine, newspapers, long underwear and more to buy, it goes quickly. He's

"While it may look like a puzzle-solving adventure as you dig tweezers out of floorboards to pry broken keys out of locks, much of the game involves seeing to Walter's needs."

generally moaning about something, but his time is as limited as his income while his problems outnumber both.

Each day, you study your to-do list and wallet, decide what you're going to do, do it, then try to deal with Walter's complaints. The university library is an important location, but is a warren of busywork. All the time the clock is

ticking, your sanity is eroding, your tiredness makes it hard to concentrate.

Truly, this is a game that speaks to the experience of living in our modern world. Yet there are other worlds to explore too, with a monster-infested maze and a witch's hut haunting Walter's dreams, where he is whisked away down a purple tunnel, and bitten by a man-faced

rat. It gets to the point that, while a good night's sleep would be helpful for his stats, you hope for a dream as they're the most interesting parts of the game.

Dreams in the Witch House is interesting, but the repetitive presentation here renders it dull. Ian Evenden

★★★★☆



NIGHTMARE ZAPPER

Explore a horror story with your remote.

■ Free | PC, Mac, Linux | Free PC bit.ly/NightmareZapping

Thankfully, nothing crawls from the screen in Nightmare Zapper, but it does contain a whole network of channels that tell a connected horror story. You control it by clicking 'Next', as if browsing listlessly one night with the TV remote. While the majority of the numbers are tuned to static, you'll stumble across lots of horrific little snippets.

If you do so, you can return later to watch it again from the beginning. But there are also interactive stories, with endings that can change the state of the meta-narrative. You make dialogue choices, or in one case solve simple point-and-click puzzles. The most substantial of these stories is one where you get up, have breakfast and pray, before leaving the house.

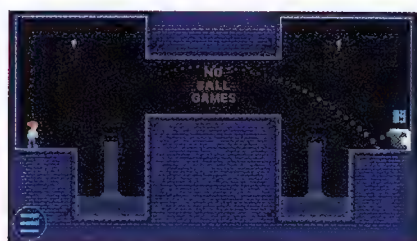
It's not immediately obvious how you can change the outcome of this scene – but the solution, fear not, is in this sprawling game somewhere. I would have welcomed more of this meta stuff, but there is just enough here to make your eyes light up as you comb the channels for clues, and cycle through them two or three times to reveal the true ending.

A collection of jagged horror titbits, with a clever framing device that turns them into a cohesive narrative.

Tom Sykes

★★★★★





## FREEKICK UNDERGROUND

Playing footie in a sewer.

■ Free | Browser | [bit.ly/FreekickGame](http://bit.ly/FreekickGame)

If you've ever attempted to dunk a basketball you'll know the pleasure that comes from trying to achieve perfection through repetition. *Freekick Underground* captures that pleasure with remarkable accuracy.

You, the free-kicker, are trying to reach some distant goalposts, which you have presumably lugged to the sewer for your subterranean pastime. Each of the 15 levels is a challenge of environmental geometry, as you try to apply just enough height and pressure to punt the ball into the back of the net with a single kick.

As you can't move the little footballer – just decide the height and power of their kick – there are only two keyboard keys to worry about: Up and Right. Up moves the height meter, and Right increases the power gauge.

The swing mechanics are so granular they allow for these little strokes of luck which combine with a growing skill, honed by clearing the early levels. Perfection through repetition, though without the frustration that often accompanies skill-based puzzle games.

I devoured all 15 levels, and was sad when they ended  
**Tom Sykes**

★★★★★



apc  
HIGHLY  
RECOMMENDED

## DREDGE

A near-perfect Lovecraftian fishing experience

■ PC, PS4/5, XB1/S/X, Switch | [dredge.game](http://dredge.game)

Life in *Dredge* is Lovecraftian as hell, wonderfully ominous and effortlessly moreish all at once. Things start off simple enough: my poor fisherman has wrecked his vessel near the small island town of Greater Marrow. After being offered a replacement and a small debt for the pleasure, I'm on my way to start fishing.

Getting a target to align with green zones dotted along various shapes reels fish in. Some have my target spinning around a circle, while others have it swinging between two curved bars. The real challenge comes from what to do once I've landed my catch.

"Fish come in all shapes and sizes, which I have to fit, Tetris-style into my vessel's tiled inventory."

Fish come in all shapes and sizes, which I have to fit, Tetris-style into my vessel's tiled inventory.

The real mystery and its dangers begin once my debt is cleared and I approach a strange collector on a nearby island, who sends me to collect relics strewn across four islands. Each has its own quirks – Gale Cliffs features a giant monster that lurks between the rock faces, while Stellar Basin has tentacles that threaten to destroy my vessel unless I find a way to placate them.

There are a few ways to deal with

these problems: handing in a relic to the collector grants you mystical abilities. Early on I'm given Haste, allowing me to speed along the waters. But these come at a cost. A panic meter rears its ugly head when the sun sets and these mysterious powers are utilised.

The more it increases, the more terrifying things become. I begin to hallucinate red-eyed crows swarming

my boat, and giant monsters emerge from the waters to rip my vessel to shreds. I can offset the panic somewhat by reading skill books and plastering more lights to my boat, but the paranoia arrives

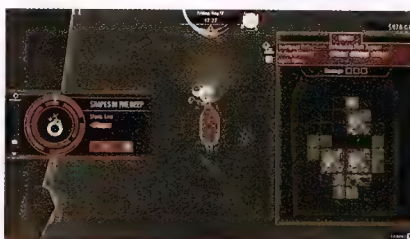
eventually.

*Dredge* is worth the tidy 15-hour completion time. If you love horror and fun fishing minigames, this is for you. It's not perfect, and the frustrating moments are obvious. But that won't stop me from returning to fill out its twisted encyclopaedia.

*Dredge* is a fantastically twisted fishing horror full of charm. It snags in parts but still managed to reel me in.

**Mollie Taylor**

★★★★★





## TCHIA

Explore a beautiful tropical island using magic powers

■ \$TBA | PC, PS4/4 | [awaceb.com/tchia](http://awaceb.com/tchia)

Tchia is a third-person open world adventure where you play as a little kid (named Tchia) living on an archipelago based on the real-world South Pacific island of New Caledonia. While beautiful and tropical, Tchia's island is no paradise. An evil overlord named Meavora has filled the island with creepy, golem-like foot soldiers made of fabric, and a vicious henchman has abducted Tchia's father. Tchia sets out to free her dad with the help of her newly-discovered power to 'soul-jump' into animals and inanimate objects and possess them.

For as long as her soul meter is filled, Tchia can control the things she possesses, creatures like birds and dolphins and crabs and objects like oil drums, rocks, and coconuts. When I need to cross the island quickly, I target a bird, soul-jump into it, and then I am the bird. I flap my wings and glide through the air over the continent. When I've arrived at my destination (or my soul meter runs out), I pop out of the bird and I'm Tchia again.

The more I do it the more fun it becomes.

Over the course of my adventure I grew incredibly fond of Tchia. Her

coming of age story has some relatable awkward moments, plenty of funny encounters (trying and failing to invent a cool secret handshake with a new friend had me laughing throughout), genuinely tragic events, and even a bit of wholesome childhood romance. The island itself is beautifully brought to life by the developer, Awaceb, which is

from New Caledonia, and the voice acting and music – the game is entirely in the languages of French and Drehu – are performed by New Caledonian locals.

Tchia (the game) is an absolute delight, an enchanting world that

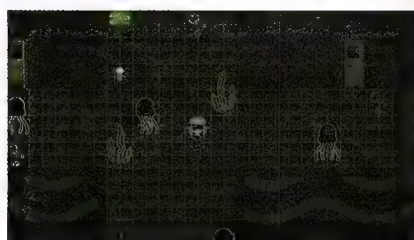
is filled to the brim with adventure, excitement, beauty, physics-driven fun and lots of charming characters, none moreso than Tchia (the kid) herself. She may throw her soul haphazardly into crabs, birds, fish and coconuts, but her heart always stays right where it is.

"Filled to the brim with adventure, excitement, beauty, physics-driven fun and lots of charming characters."

Tchia from developer Awaceb has to be one of the best open-world games to come along in quite some time.

Christopher Livingston

★★★★☆



## BLACKOUT HOSPITAL

Save a monstrous medical centre.

■ Free | PC | [bit.ly/BlackoutHospital](http://bit.ly/BlackoutHospital)

You play as a hospital janitor in this turn-based RPG, which combines a Silent Hill-like setting with vivid characters and enemies reminiscent of Persona. It begins with the solitary Vasilis (that's you) cleaning up spills around the hospital as usual, before a blackout turns your familiar world on its head.

Most of the staff and patients disappear, although there are now monstrous creatures and ghosts roaming round the halls. Initiate a fight – most won't attack first – and you're in familiar 16-bit RPG territory, especially when you've picked up a few party members.

There isn't a lot to chew on when it comes to combat, with only a few abilities per character, meaning you'll use the same tactics again and again. However, battles are a surprisingly small part of the game, and you'll go long stretches without encountering enemies at all.

You won't forget the characters: a memorable cast that includes a highly strung bride, a ravenous boy with an open stomach cavity, and Mary, a hospital patient with an enthusiasm that transcends her debilitating illness.

It's an OK RPG, but you should play this one for the story and cast.

Tom Sykes

★★★★☆









GAME CHANGER

## Outcast

*A cinematic action adventure that reaches for the stars. By Robert Jones*

■ Release: 1999 Developer: Appeal Publisher: Infogrames Link: [bit.ly/3Fa10Rj](https://bit.ly/3Fa10Rj)

Step with me my friend back to the now very distant past of 1999. Stepping out of our time machine we now exist in a PC gaming world where beige PC tower rigs rule the roost, 3dfx Voodoo graphics cards are still a thing, and *Team Fortress Classic* is being played over LAN in APC Towers. Oh, and *Outcast* is hitting store shelves in all its big-box PC glory.

And, despite sales that will go on to be described, at best, as modest; and the fact that its maker Appeal will go on to bankruptcy within two years of its release, *Outcast* is about to change the scope and vision of videogames as a medium forever. All truly great pieces of art stem from ambition. That desire to push the boundaries of what is considered possible, and with its stunning (for the time) voxel graphics engine, expansive scope, professional musical score and complex in-game mechanics,

*Outcast* remains even to this day one of the most visionary and ambitious games of all time.

### Alien technology

*Outcast's* story of a group of humans transported to a parallel universe and becoming involved in a time-warping adventure over multiple worlds, encountering numerous alien species, and having to defeat a big bad in order to save the Earth was nothing new in 1999, but the fact that *Outcast* truly reached for the stars in how it did so absolutely was.

With six large and vastly different alien worlds to visit during the course of the game, and for each of those lands to stretch out before your eyes to incredible distances, powered by the game's unique 'voxel engine', was – and you'll have to trust me here, as a guy who played *Outcast* back in 1999 on his own beige tower rig

Above: The water effects in *Outcast* were breathtaking in 1999.



– truly mind blowing.

Oh, and did I mention the water and portal effects? At the time these were graphics that truly felt like they were from an alien world, and one that existed in our future, too. It was like Appeal had itself managed to travel into the future of videogames and return armed with abilities far beyond any other dev in 1999.

It wasn't just the graphics that felt game-changing, either. *Outcast* came with a full musical score courtesy of the Moscow Symphony Orchestra, which matched the game's graphical vision in terms of scope and quality. Today, in 2023, games with their own big-budget musical scores are quite common and nothing to write home about, but back in 1999 it was unheard of.

Wrap this together with a game that featured hundreds of NPCs, many of which featured full, well-delivered voice acting, third-person and first-person gameplay





Not all worlds are this idyllic, with threats common.

modes, context-sensitive reactions by NPCs based on what the player does, numerous cinematically shot cutscenes, a variety of weapons to acquire and upgrade, and even wild, Tauntaun-like beasts called Twon-ha to tame and ride, and the ambition and complex vision of Outcast becomes incredibly evident.

### Offbeat symphony

The thing is, though, replaying Outcast again in 2023 courtesy of GOG's much-needed 2010 re-release (the game was basically unplayable on most gaming systems a decade after its release, so GOG's release essentially made it possible for most PC gamers to play it again, or for the first time), it's obvious that in reaching for the stars it stumbles here and there when it comes round to delivering a great videogame.

There's no doubting that the start of the game will be very off-putting to many gamers, with what can only be described as a humongous info-bomb of phrases, lore,

## MAP-AZAAR

*A tourist guide to the six worlds of Outcast*

### 1 SHAMAZAAR

A tropical world filled with temples, palm trees and pools of water.

### 2 TALANZAAR

A world that features the city of Okriana, location of the Palace Fae.

### 3 OKAAR

A forested region filled with various ancient structures.



### 4 MOTAZAAR

A barren, volcanic world filled with lava and geysers.

### 5 OKASANKAAR

A water-filled, marshy world dominated by the city of Cyana.

### 6 RANZAAR

A world of snow and ice and home to the Dolotai guardians.

character names, mechanics and locations dropped on the player. By modern videogame standards there is very little hand-holding or signposting, either, so you really do have to soldier on through the first few hours of Outcast to feel at home in its world.

Cutter Slade, the protagonist hero of Outcast, an ex-US Special Forces badass sent to the parallel universe to save now stranded scientists, also handles clunkily, despite a moveset that includes running, jumping, swimming and crawling. Generally this doesn't get in the way of enjoyment, but during the game's rare stealth or platforming sections gamers will no-doubt end up cursing the game for undeserved failures.

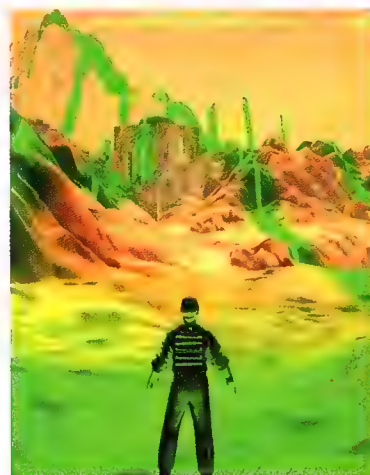
The structure of the game will also likely appeal – see what I did there! – or rub gamers up the wrong way depending on how linear they like their gaming experiences. Outcast has a largely non-linear structure, allowing players to explore and discover areas, NPCs and quests in whatever way they





Left: Twon-ha can be bought or tamed, and then ridden.

Right: Portals link the various worlds in *Outcast*.



want to. However, discovering these things requires non-signposted, slowburn adventuring, as well as the listening to NPC dialogue, so if you prefer go-there-do-this quest markers and short mission times then *Outcast* will likely feel at odds with you.

Combat, too, while far from terrible and perfectly acceptable still in 2023, lacks a tightness and punch of more modern action adventures. Typical combat encounters involve quite slowly strafing left and right while firing your weapon at distant alien foes (there's no cover mechanics or dodge manoeuvres), and it very rarely gets more exciting or dynamic than that. While 1999's most exciting and dynamic games in terms of combat, *Quake 3 Arena* and *Unreal Tournament*, had not been released when *Outcast* hit store shelves, the fact is that its combat mechanics were far from best in class then, so now they really do feel dated.

The same was true as well back in 1999 in terms of the game's movement mechanics, with Cutter coming off second best to Lara Croft, who was backflipping, running and rolling while firing

dual pistols a year earlier in *Tomb Raider III*. It's not as if Slade handles particularly badly, it's just that in the grand scope of this game, the movement in combat just feels a notch or two off where it should be. And while the ability to go prone and crawl commando-style feels accurate for an ex-US Special Forces badass, the lack of other dynamic movement, especially in combat, does not.

#### A flawed masterpiece

What emerges then playing *Outcast* again today is a feeling of a game that was genuinely pushing at the outer rim of gaming, it was reaching for the unknown, and as ever with that process, not everything ends in success. So many of its traits, features and mechanics are now incredibly evident in modern games, and many have become the accepted norm.

For example, the way large parts of the game are shot cinematically, both in and out of cutscenes, is incredibly reminiscent of, say, *Mass Effect*, while its reactive context-sensitive system for NPCs and their factions can still be seen in games like *Cyberpunk 2077*. Meanwhile,

*Outcast*'s mix of combat, exploration and item collection evokes more recent open world games like *Assassin's Creed*, and its multi-world structure echoed to a degree in games like *Star Wars Jedi: Fallen Order*. And that's saying nothing of the heavily narrated storytelling that you can find in later games stretching from *Dragon Age* to *A Plague Tale*.

But back in 1999, just as *Outcast* reached into the unknown with its voxel engine and delivered a stunning but difficult to process (literally, as the engine did not use a system's graphics card at all, and instead loaded everything on to its CPU and RAM) experience visually, it did so with a pioneering rawness that extended to most aspects of its design, and not all of those hit home or, like the voxel engine, endured.

In *PC Gamer*'s original review of *Outcast* back in August 1999, they concluded that, "*Outcast* is undoubtedly a masterpiece; the trouble is that it may never be recognised as one." In 2023, though, *Outcast*'s recognition and legacy is beyond doubt.

A flawed masterpiece whose influence stretched far beyond its own commercial success. ■





RETRO

# Xerox Alto: a window to a new world

*Xerox's ground-breaking personal workstation, the Alto, introduced many computing concepts that are still in use 50 years later. David Crookes steps back in time.*

When Apple unveiled the Macintosh computer in 1984, there was one thing in particular that captured people's attention. It was the System 1 operating system boasting a clean, black-and-white graphical user interface (GUI), which filled the screen with windows and icons.

For anyone familiar with a command-line interface, it felt revolutionary. In fact, as Lawrence J Magid wrote in the *Los Angeles Times* in January 1984, the computer "started a fever in Silicon Valley that's hard not to catch".

In extolling its virtues, he compared it to a previous Apple release: the Lisa, which also made use of a

GUI. The difference, he noted, was that the Lisa retailed at US\$10,000 while the Macintosh was selling for a more wallet-friendly US\$2,495. "The new Macintosh has gotten off to a delicious start," he proclaimed.

Yet Magid didn't mention the computer that had inspired Steve Jobs to create both machines – a computer that, as time attests, was arguably the most influential of them all. Then again, it was easy to overlook the computer in question – the Alto – primarily because its maker's management

failed to do anything meaningful with it.

That company was Xerox, founded in 1906 as a manufacturer of photographic paper and equipment. After 1959, it had achieved huge success with the 914 plain paper photocopier, generating close to \$600 million revenue in just two years.

For Xerox, the main focus was on copiers and laser printers, but it nevertheless had the foresight to create a ground-breaking research laboratory. The Xerox Palo Alto Research Center (PARC) in California was unusual because it worked independently and it wasn't influenced by the products that were being made by its corporate parent.

Instead, those who worked at PARC were largely free to experiment. The process of informal collaboration was nicknamed "Tom Sawyering" – the idea being

that someone would come up with a project, start work on it and motivate a few like-minded souls to assist.

The more people someone could encourage to work on a project, the more likely it would be to go ahead. It led to many innovations.

**"It was easy to overlook the computer in question – the Alto – primarily because its maker's management failed to do anything meaningful with it."**



Above: The Xerox Alto had a bit-slice processor based on the TI 74181 chip.

## Why Alto?

The idea to create the Alto emerged in September 1972. Two months later, researcher Chuck Thacker was working hard on its design alongside computer scientist Edward McCreight. In December, principal scientist Butler Lampson, one of the founding members of Xerox PARC, wrote a memo called "Why Alto?" He asked Xerox to back the machine.

Lampson said the original motivation had been provided by Alan Kay, who joined PARC as a researcher from Stanford University's Artificial Intelligence Laboratory in 1970 (PARC's close proximity to the university played a huge part in its success, allowing it to attract some of the best brains).

He explained that Kay needed computers for his education research and that the Alto was able to provide all he needed and more. The end result was a



computer with 128KB of memory, a 5.8MHz CPU, a 2.5MB removable cartridge hard drive, a 64-key keyboard and a three-button mouse. It had a bitmapped black-and-white display that was vertically aligned and the size of an A4 sheet of paper. The Alto was ready by 1 March 1973.

"The Alto was so far ahead of its time," engineer Josh Dersch told APC. He wasn't involved in the original project but spent over a year creating an Alto emulator many decades later. "It gets a ton of deserved credit for its user interface inventions but it was also ahead of the curve on so many other things."

In delving deep into the inner workings of the Alto to create his emulator, Dersch has come to know the Alto well. He got to use one for the first time at the Living Computers Museum in Seattle, Washington, after its curator Paul Allen decided to restore a couple of original machines six years ago.

There was a resurgence of interest in the Alto at that time. For one, American technology startup accelerator Y Combinator worked on restoring Kay's own computer. The Alto source code was also released, with the Computer History Museum in Mountain View, California, making the code available for download ([tinyurl.com/APC520SOURCE](https://tinyurl.com/APC520SOURCE)) in 2014.

One thing became clear to anyone working on such projects



who had never seen the Alto before: this machine with its 13 chip-crammed circuit boards (three of which comprised the CPU) worked exceptionally well. It was also evidence of an experimental time.

"Prior to using a real Alto and working on the emulator, I didn't realise how varied the interfaces on Alto programs really were," explained Dersch.

**Smalltalk, big thinking**

The decision to create a GUI-based OS for the Alto had been inspired by engineer Douglas Engelbart, who had developed a

prototype computer information system that introduced the concept of hypertext links, raster-scan monitors, videoconferencing, onscreen windows and a mouse.

Called the "oN-Line System" (NLS), it was demonstrated in December 1968 – the same year Kay developed the FLEX language aimed at making programming accessible. This evolved into an object-oriented programming language called Smalltalk.

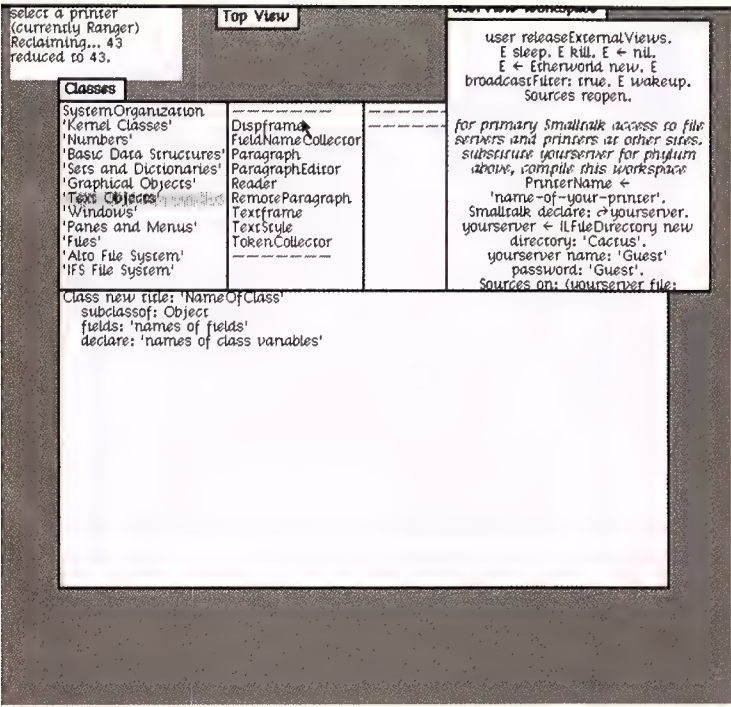
"When most people talk about the Alto's user interface, they're really referring to Smalltalk-76," Dersch explained. "There was an underlying OS (the Alto Executive) which had many updates but the real features were the applications and systems that were built over time to use the Alto's features."

It was Smalltalk-76 that Steve Jobs saw in 1979. Apple had approached Xerox offering the opportunity to purchase stock options in the company in exchange for a demonstration of Xerox technology.

When Apple's engineers arrived, PARC's computer scientists were all too happy to share their work. In their mind, Xerox was not making sufficient use of the technology that had gone into making the Alto and they could see that Apple's engineers were enthused.

Jobs accompanied the engineers on a second visit and he liked what he saw, ensuring the Lisa and Macintosh would be based around a GUI-focused OS.

Inspired by the Alto, Apple created a GUI-based operating system for the Lisa.



Left: See how the Xerox Alto works by using the emulator at <https://archives.loom.com/contraaltojs>.





"Smalltalk had the most polished interface and it's the thing that inspired Jobs and Apple to make their own version," said Dersch.

"The key innovations were overlapping windows, each corresponding to a separate activity or interaction with the user – these could be moved, resized and have their order changed. There were pop-up menus, scroll bars for scrolling through content and multiple desktops (or subviews in Smalltalk parlance)."

The Alto development also indirectly inspired Bill Gates at Microsoft. At that point, although still fresh from its success of helping to shape the IBM Personal Computer 5150 with MS-DOS, it was still developing software – including for Apple, and that meant it had early access to the GUI and to prototypes. It's little wonder that Gates wanted his own company to produce a rival to System 1. Much to Steve Jobs' annoyance, it led to Windows 1.0 being released the following year, running as a graphical shell on top of MS-DOS.

As well as working on the operating system, the engineers at PARC developed software for the Alto. "The Bravo word processor provided WYSIWYG text editing but the user interface was relatively primitive, with a modal interaction model," said

Dersch, of an app that would later inspire Microsoft Word. "The mouse was used to select text and scroll through documents.

"There was a simple file manager called Neptune that gave a two-pane view of files on the disks in the system and allowed selecting files with the mouse and performing actions (moving, copying, deleting) on them.

"The SIL engineering drawing program had a graphical menu that popped up a grid of options wherever the mouse was currently pointing, making it relatively quick, motion-wise, to find and select the action the user wanted," he explained.

Yet, as Dersch pointed out, the interfaces for the various applications were experimental and constrained by the limited power of the Alto. "The computer was also designed by engineers, for engineers and in a lot of cases there wasn't a lot of real-world user testing, so the interfaces tended to be a bit obscure and had interesting learning curves," he added.

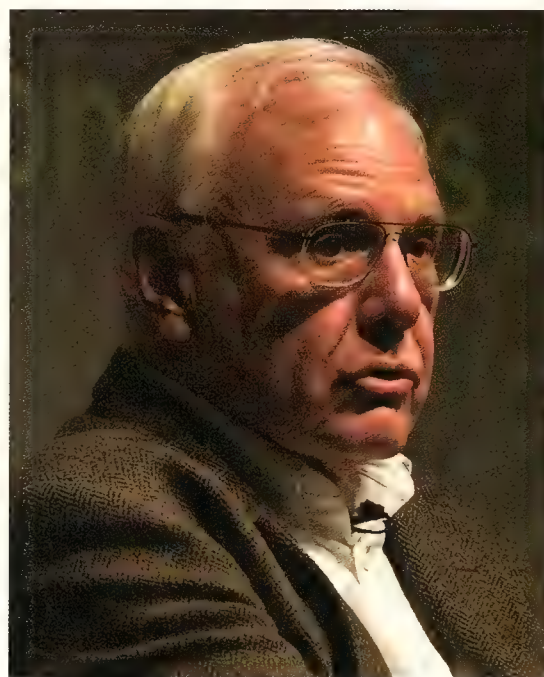
"Smalltalk was the exception to this: one of the design goals was for it to be an environment and language usable by children, and there was a lot of testing and experimentation with kids using it, so it had a lot more refinement.

"As for the Alto itself, it pretty



Above left: Alto was made available for research use but it was never mass-produced. Above: The keyset and mouse buttons enabled users to type a full alphanumeric character set.

much predicted the modern PC: a personal device that included local storage, a graphical display with keyboard and mouse, Ethernet networking and multimedia capabilities. Certainly everything in a PC today is faster and has more capacity, but apart from that, it's not all that different from the Alto in the mid-1970s."



Chuck Thacker, project leader on Xerox Alto, also co-invented Ethernet.



## Well, bravo

The idea for a local computer network emerged in 1966 courtesy of Larry Tesler, who had graduated from Stanford the year before. Tesler began working at PARC in 1971 and ended up on the team developing the Alto, working on Smalltalk and the Gypsy word processor.

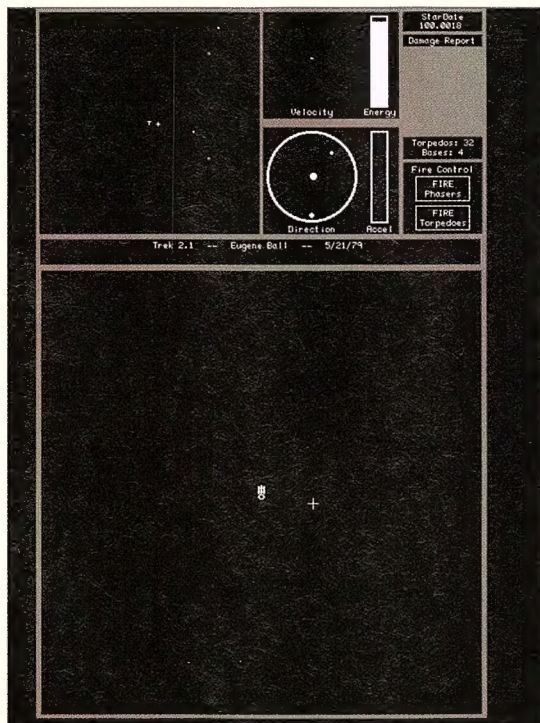
A couple of years later, Thacker, Lampson, Robert Metcalfe and David Boggs invented Ethernet, which Xerox patented in 1975. "Ethernet networking and the protocols built on top of it allowed Alto users at PARC to communicate with each other via email, to transfer files, to report diagnostic failures to technicians, to send print jobs off to [Alto-driven] laser printers, and to play games. Altos could even be booted from the network," Dersch said.

Trouble is, there weren't actually that many users. Only 2,000 Alto computers were ever built and they cost US\$32,000 to buy. But those who could gain access – most users were in Xerox laboratories, a host of universities and congressional offices of the US House of Representatives – were able to reap the benefits.

"The Bravo word processor, in combination with the laser printer [also invented at PARC], allowed users to create extremely high-quality print output," said Dersch. "An interactive font editor called FRED allowed the design of high-quality typefaces, and there was experimentation with desktop publishing as well.

"SIL and ICARUS provided graphical facilities for PCB and IC design, which could be processed and handed off to manufacturing in record time. And Smalltalk evolved into the Smalltalk-80 standard that was released to the world. It never found major success but influenced countless other languages. It lives on today as Squeak, still being maintained by some of the original Smalltalk creators."

Thanks to Dersch, more people are now able to see what all the fuss is about, and it's certainly worth giving his emulator, ContrAlto, a try. He's continuing to work on it, in particular a fork of the one created for the Living Computer Museum, and he directs people to Github ([github.com/jdersch/ContrAlto](https://github.com/jdersch/ContrAlto)) where he promises to issue future updates.



Above: *Trek* introduced the idea of controlling a starship to destroy enemies.

"There were a few reasons I was inspired to work on the emulator," he said. "The Alto was such an important part of computing history that I thought it was a shame there wasn't a fully working emulator available to allow people to actually use one. It's one thing to hear the stories and look at old photographs; it's another thing entirely to actually sit down in front of one and play with the software first hand.

"The other reason was the challenge involved. There were at least two prior attempts to create an Alto emulator, but neither was completely successful, despite a ton of hard work.

The Alto's hardware is minimal but extremely cleverly designed, making it tricky to make an accurate emulation. But I had a lot of fun writing the emulator, and I'm very happy with the result."

### How much?

Had Xerox seen the value of what it had for the mass market, however, computing history could have turned out very differently. Xerox had a golden opportunity to put itself ahead of Apple and Microsoft at a crucial

moment in time. Instead, it seemed content to create expensive machines such as the Xerox Star in 1981, which introduced a GUI, icons, mouse, Ethernet, email, icons, folders and file servers to the masses – albeit at a cost of US\$16,595.

So why the reluctance to create an affordable commercial PC? "That's a question for the ages, really," said Dersch. "There's probably no one answer but, at the time, Xerox got cold feet about getting into the computer business again: it had tried with its purchase of Scientific Data System in 1969, which ended up being a terrible business decision that haunted them for years.

"It did make an attempt with the Star and its successors but they were extremely focused on integrated office solutions (although, in that respect, the Star was way, way ahead of its time). Xerox just didn't see the bigger picture of general-purpose computers for the masses."

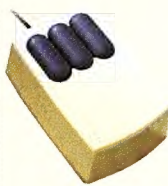
One of the issues was the fact Xerox's managers worked in Rochester, New York, 4,800 kilometres away from Palo Alto. "PARC had visionaries coming up with amazing ideas for the future and they were easily a decade ahead of their time in that respect," said Dersch. "But it was difficult to communicate these far-out ideas to the upper management."

**"Had Xerox seen the value of what it had for the mass market, however, computing history could have turned out very differently."**

Even so, 50 years on, the Xerox Alto has a unique place in history. While designed purely as a development tool for Xerox, it set a standard for personal computing that stood the test of time. It even contributed to the early videogame industry with some

early networked multiplayer games, including the space war title *Trek*, developed by University of Rochester graduate students Gene Ball and Rick Rashid, and *Maze War*, which had players navigating a labyrinth.

Above all, it showed that computers could be made small enough to fit in an office while being powerful enough to prove useful, and easy enough to operate. As Magid may well have written, the Alto had gotten the computer industry as we know it off to a delicious start. ■



The three-button mouse was based on Douglas Engelbart's design from the 1960s.





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## UKRAINIAN SOLDIERS USE STEAM DECKS TO FIRE MACHINE GUN TURRETS

*Seems like tower defence strategy just got a lot more real.*

War's require an army to constantly develop new technology to get an edge on the opposing side, but it seems that the Ukrainian army reckons Valve's Steam deck is good enough as-is to allow soldiers to remotely control one of its latest machine gun turrets. TPO Media covered the release of an updated model of the Sabre, a remote controlled turret that can carry military weapons from light machine guns using anti-tank rounds to rifles. The original Sabre turret was built by a Ukrainian crowd funding campaign from 2014 that emerged following a prior invasion in the region by Russia.

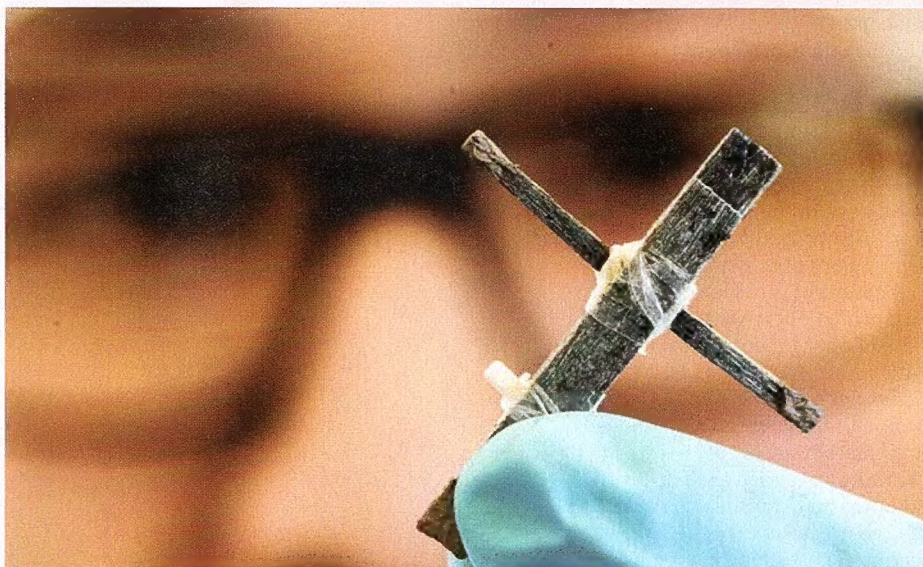


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## FRUSTRATED WARZONE PLAYERS SEND GAME DEVS PIZZAS IN PROTEST

*Vega Warzone players send pizza message to CoD devs or a bug fix.*

Call Of Duty: Warzone 2 had a major Season 3 update launch in mid April, an update that seemed to crash for anyone using an AMD Radeon RX Vega or integrated AMD graphics processor. After a week of the red team seeing red in Reddit chatrooms, Beenox – the Canadian, Activision Blizzard studio that handles CoD on PC – Tweeted that it was investigating the AMD Vega issue and was 'actively working on a fix'. After another week of being sidelined at a critical juncture in the popular battle royale there was a [change.org](#) petition that demanded Activision take action or refund Vega players and one reddit user even sent a 'protest pizza' to Beenox with a message saying 'Help Vega Please'.



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CHIP CHAT

## World's first wood transistor

*The descendants of Vikings repurpose wood for the modern era.*

Researchers from multiple Swedish institutions have created the world's first transistor out of wood. The team removed the lignin from balsa wood and replaced it with a conductive solution that allows the wood to transmit and modulate electric current. These wooden transistors come in at a width of 3cm and run at a max of 1Hz, instead of the 3nm 5GHz-plus we see on today's top silicone transistors, but the researchers note; "Yes, the wood transistor is slow and bulky, but it does work, and has huge development potential." If nothing else wooden processors would be even better at running halt and catch fire commands.

TikTok

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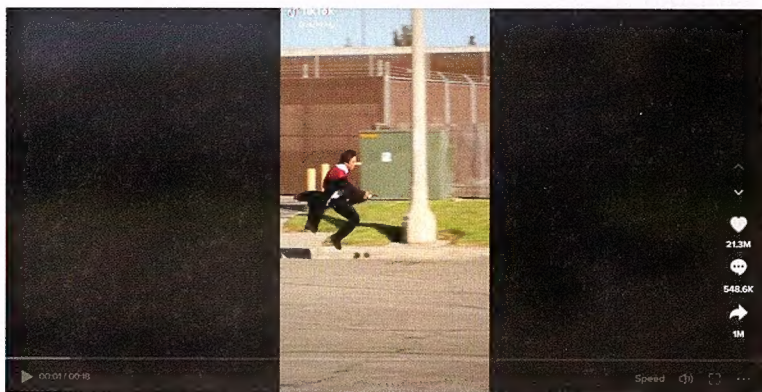
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They rejected my application to Hogwarts but I still found a way to be a wizard. // #illusion #magic #herypotter

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French Fries TikTok

## GOVERNMENT BANS TIKTOK ON EMPLOYEE DEVICES

*Commonwealth employees will have to get their snappy vids elsewhere.*

Australia's Attorney General Mark Dreyfus announced in April that the popular social media app TikTok would be banned on all government devices. In a statement the AG cited advice from security intelligence agencies as the driving force behind the ban, with Australia following the US, UK, New Zealand and a number of European countries in issuing similar bans on the Chinese owned software. The ban is currently only for government issued devices, but does raise concerns around the security of user data on the platform. TikTok's ANZ General Manager, Lee Hunter, publicly refuted the possibility that it is a security risk to Australians. ■

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